CHAPTER 7

SEISMIC INTERPRETATION

Chapter 7 called “Seismic Interpretation” summarizes the results of the new seismic interpretation which was undertaken in the Laurentian sub-basin project.

It corresponds to the eastward extension of the Nova Scotia Play Fairway Analysis carried out by RPS Energy / Beicip-Franlab in 2011.

The present seismic interpretation includes horizons and events already interpreted by CNSOPB geophysicists, which have been used as guide lines where available. It intends to give a full image of the Laurentian sub-basin, the South Whale Basin and West Grand Banks area, integrating all available data (wells, 2D seismic lines, gravity and magnetic maps).

The results of the biostratigraphy study (RPS Energy) led in parallel with the well-to-seismic tying and the chronostratigraphic seismic interpretation constrained the identification of all the horizons. In total, 9 horizons were regionally mapped over the Laurentian sub-basin till West Grand Banks area. They are from top to bottom:

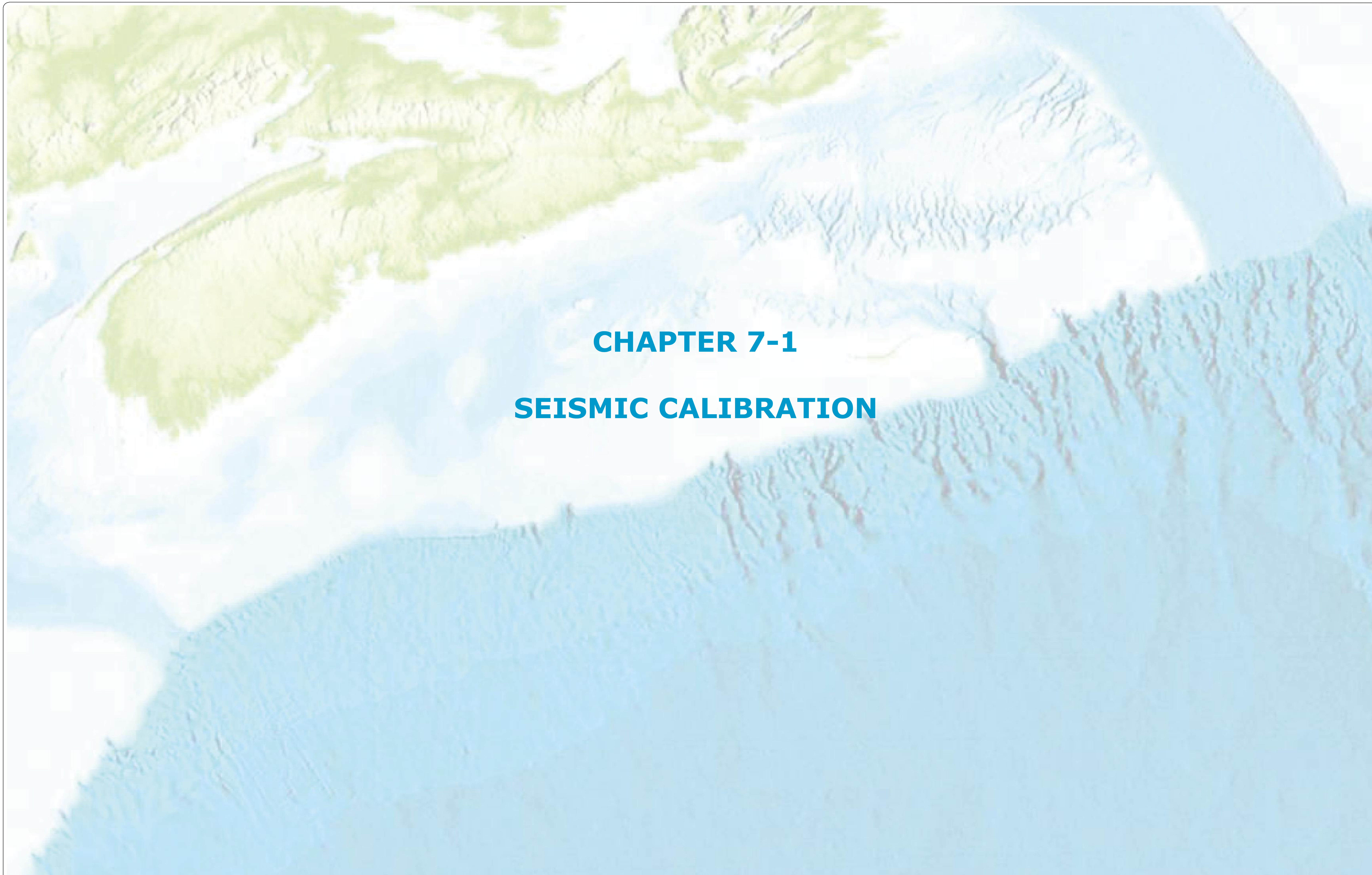
- T29 (Mid Oligocene Unconformity)
- T50 (Base Ypresian Chalk)
- K94 (Cenomanian Turonian Unconformity)
- K101 (Late Albian Unconformity)
- K130 (Hauterivian MFS)
- K137 (Berriasian / Valanginian Unconformity)
- J150 (Near Tithonian MFS)
- J163 (Near Callovian MFS)
- Base of Post-Rift sediment
- Additionnally the top allochthonous and / or autochtonous salt was locally interpreted

The Laurentian sub-basin is made of two major tectono-sequences: a rift sequence (Triassic to Early Jurassic) followed by a passive margin (Early Jurassic to present day). Close to West Grand Banks, a transform fault (Azores Transform Fault Zone) divides the passive margin into a volcanic passive margin to the Southwest from a non-volcanic passive margin to the Northeast. Autochthonous salt is present in the early inherited Triassic rift basins in the Laurentian sub-basin and the South Whale Basin but not in the Western Grand Banks. Various phases of salt remobilization due to sediment loading and gravity gliding led to the present day structural morphology of the margin.

Two structural domains and three geological provinces were identified:

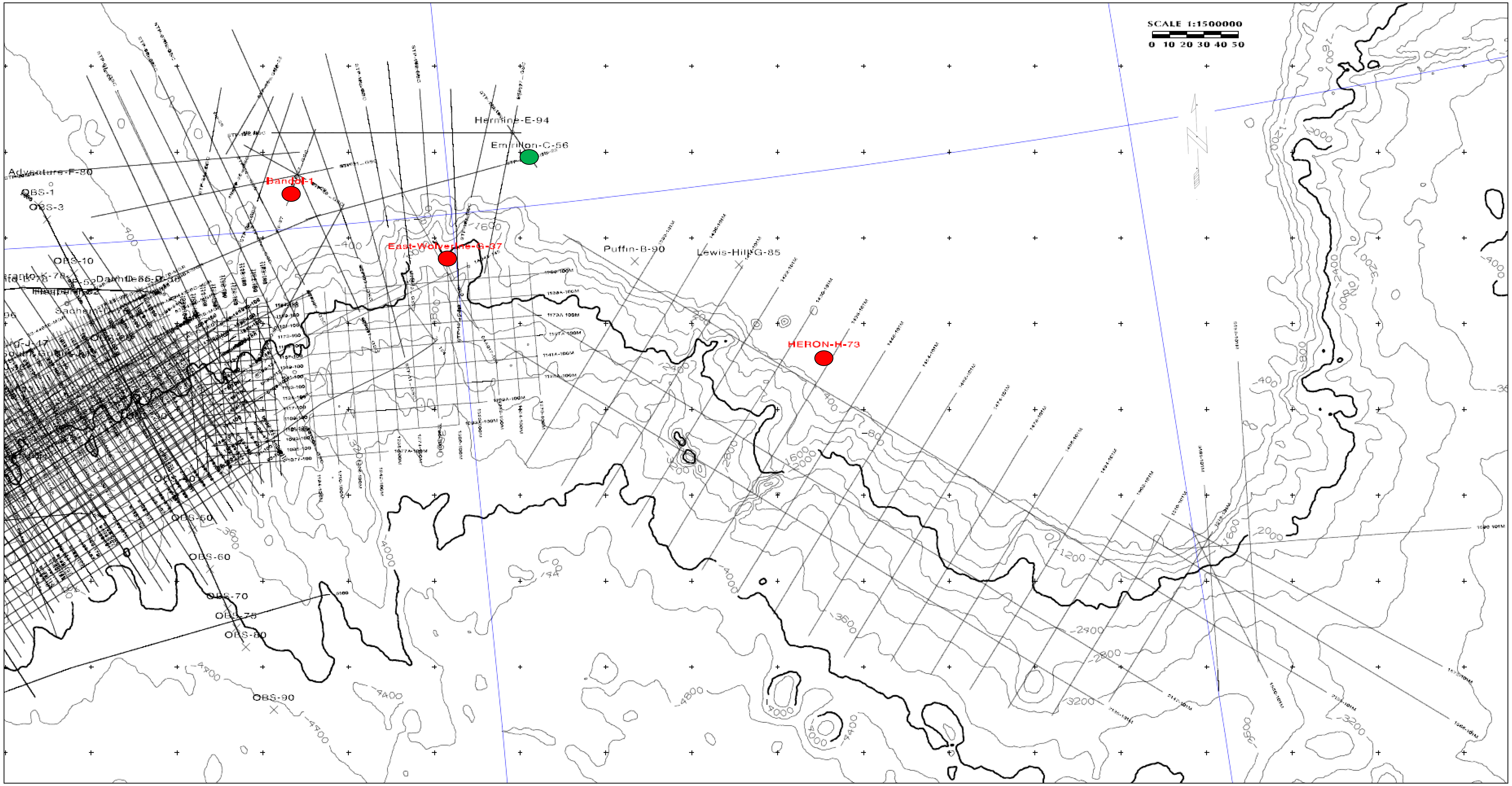
- Within the Atlantic-type volcanic passive margin: an only-autochthonous salt province (Huron area in the Nova Scotia Basin, and South Whale Basin) and a mixed autochthonous and allochthonous salt province (Laurentian sub-basin).
- Within a transform passive margin: a volcanic province with Early Cretaceous volcanic seamounts (post or syn break-up) largely affected by the Azores Transform Fault Zone (Western Grand Banks).

The depth structural maps served as the base for the Gross Depositional Environment mapping, whereas the 2D seismic line interpretation is used for the 2D basin modelling (Temis®).



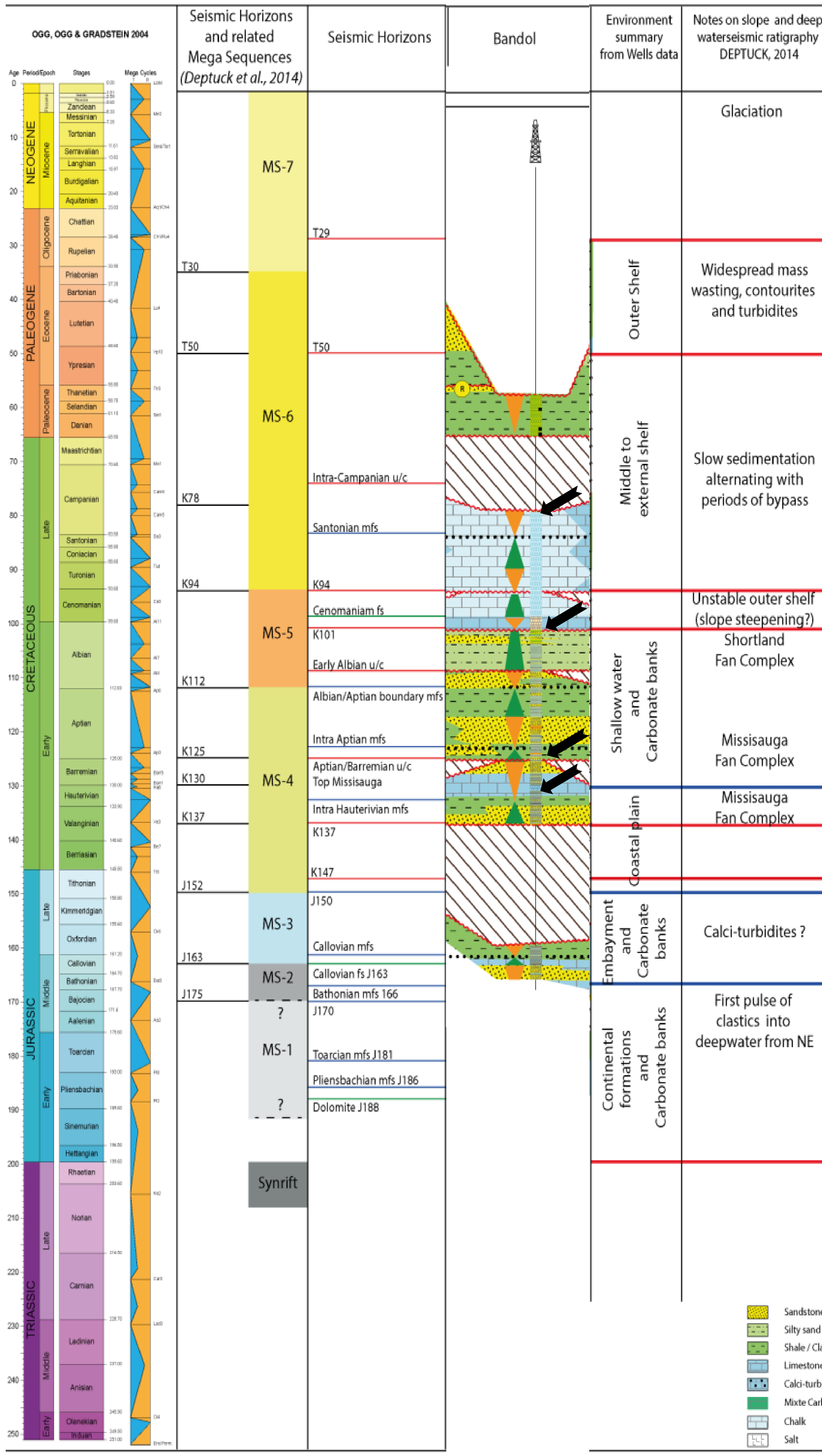
CHAPTER 7-1

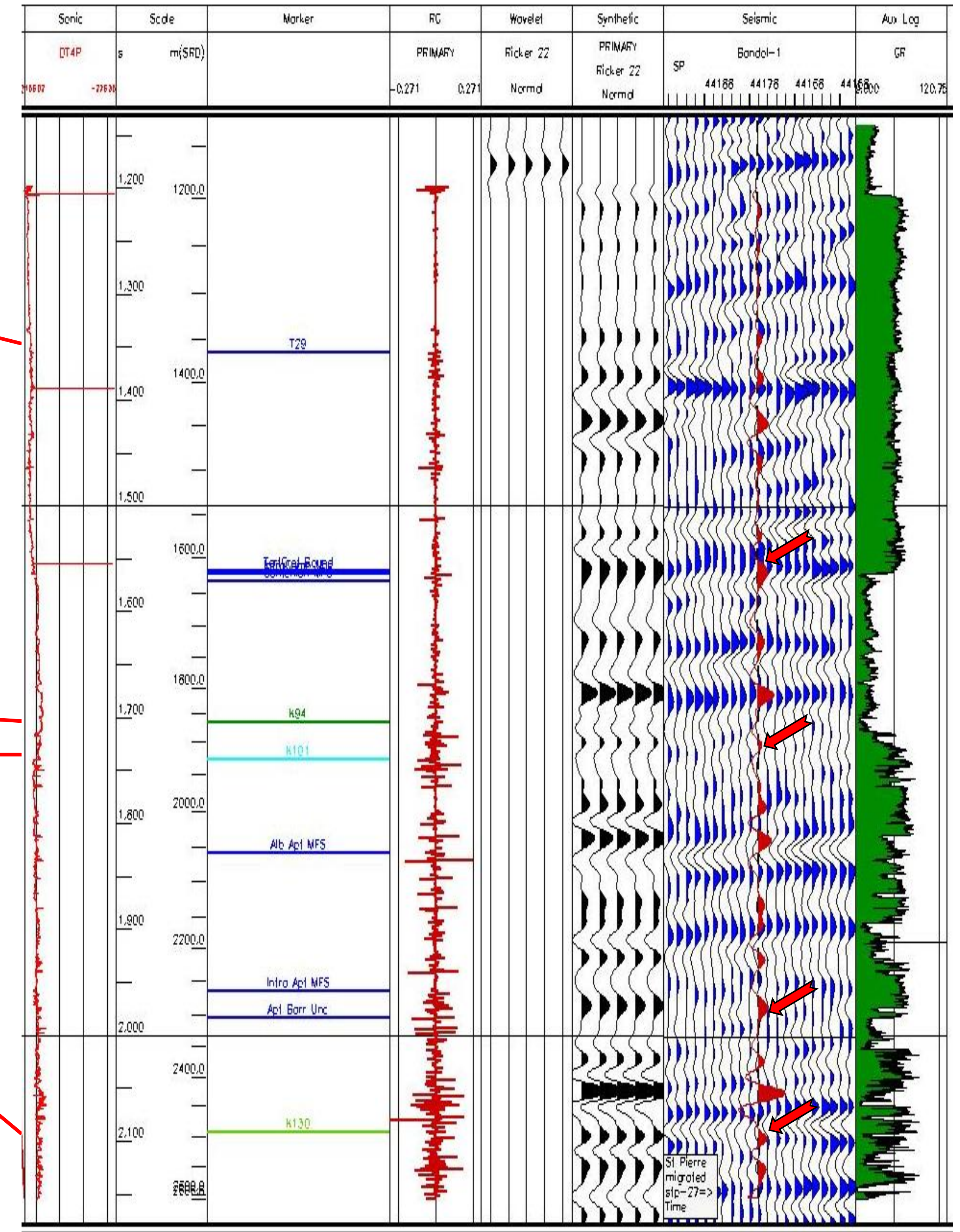
SEISMIC CALIBRATION

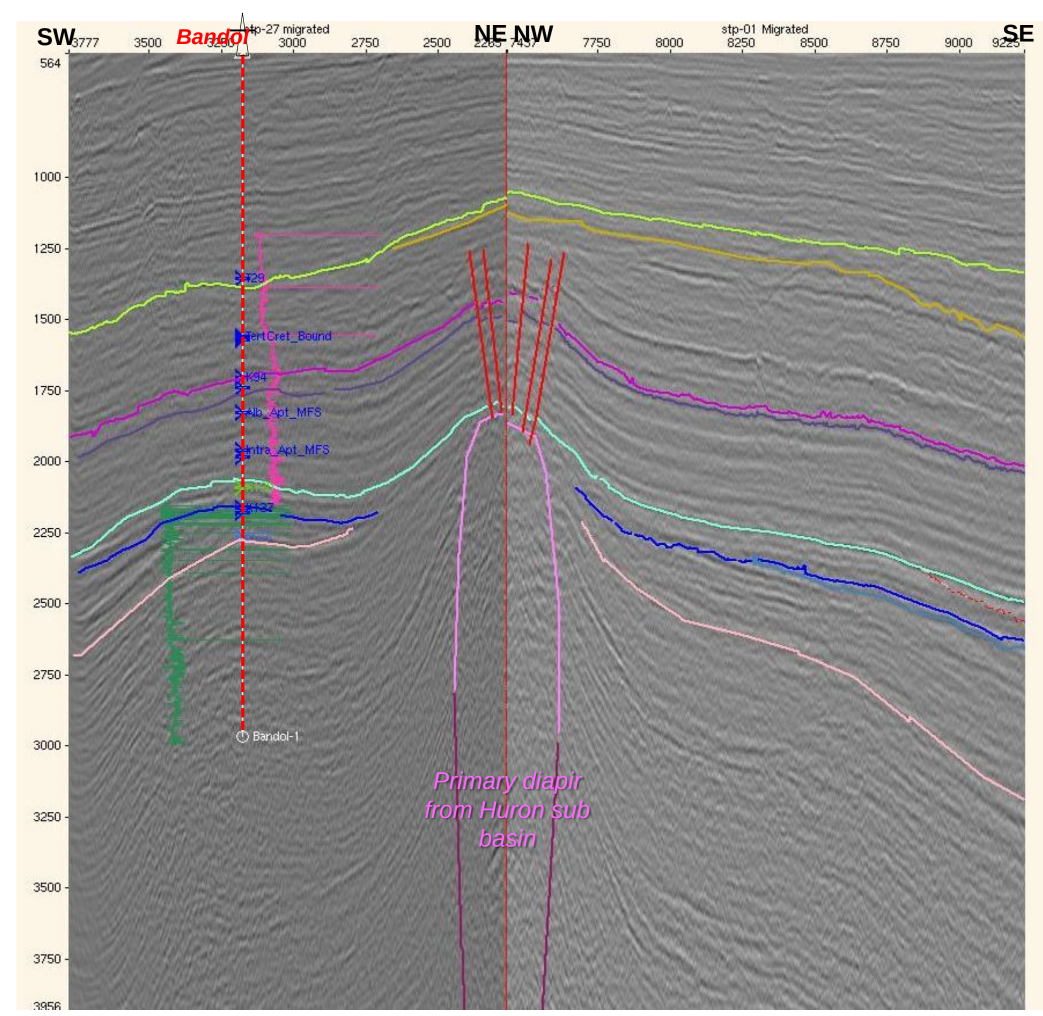


Reference well used for well-to-seismic calibration

Additional well used for constraining the seismic interpretation







Transect through Bandol-1 well with its sonic log

WELL HEADER

Well Name	Bandol-1
Kelly Bushing (K.B.)	23 m
Total Depth (T.D.)	4050 m
UTM coordinates @surface (Zone 20N, NAD27, CL66)	X: 1036055 Y: 5026000

BIOSTRATIGRAPHY

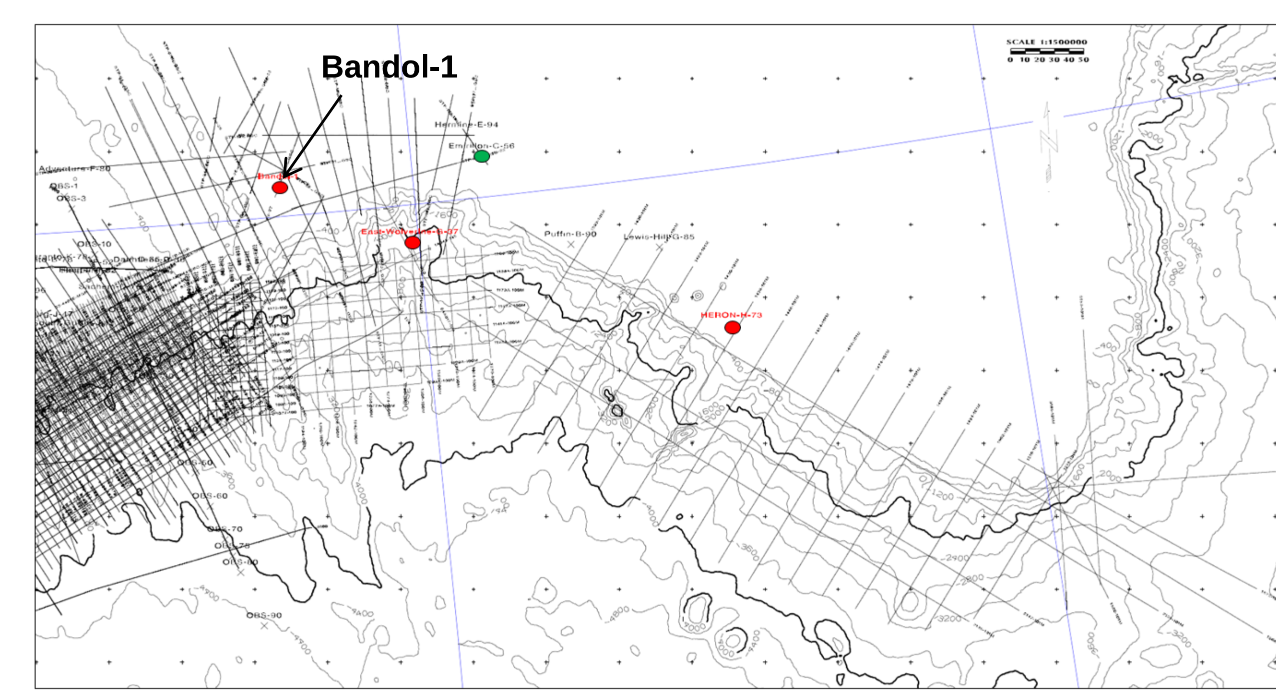
BIOSTRATIGRAPHY	RPS Energy 2014

SEISMIC LOCATION

Survey	St-Pierre
Line	STP-27
SP	44128
Time shift (ms)	58,5

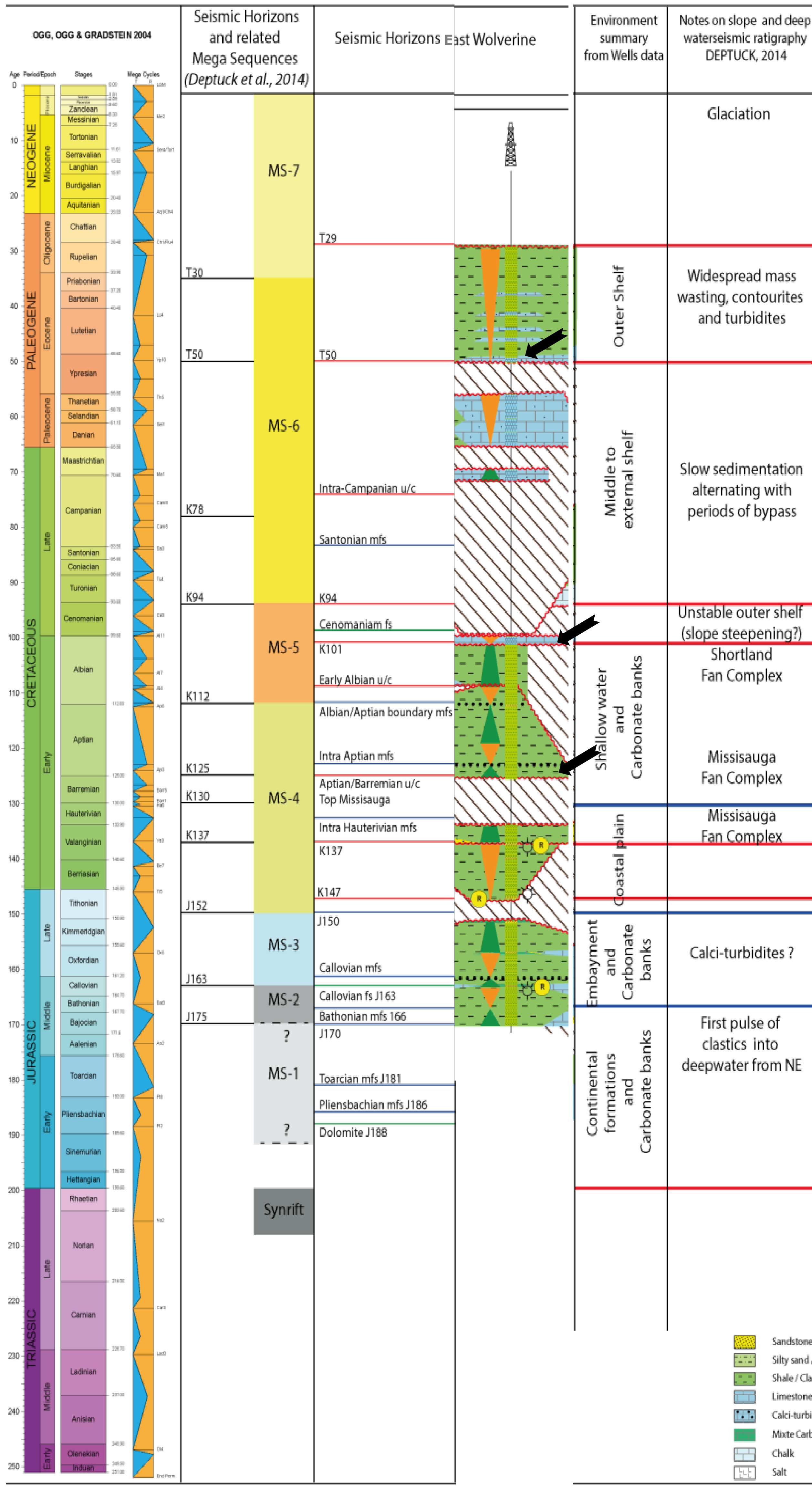
SEISMIC MARKERS

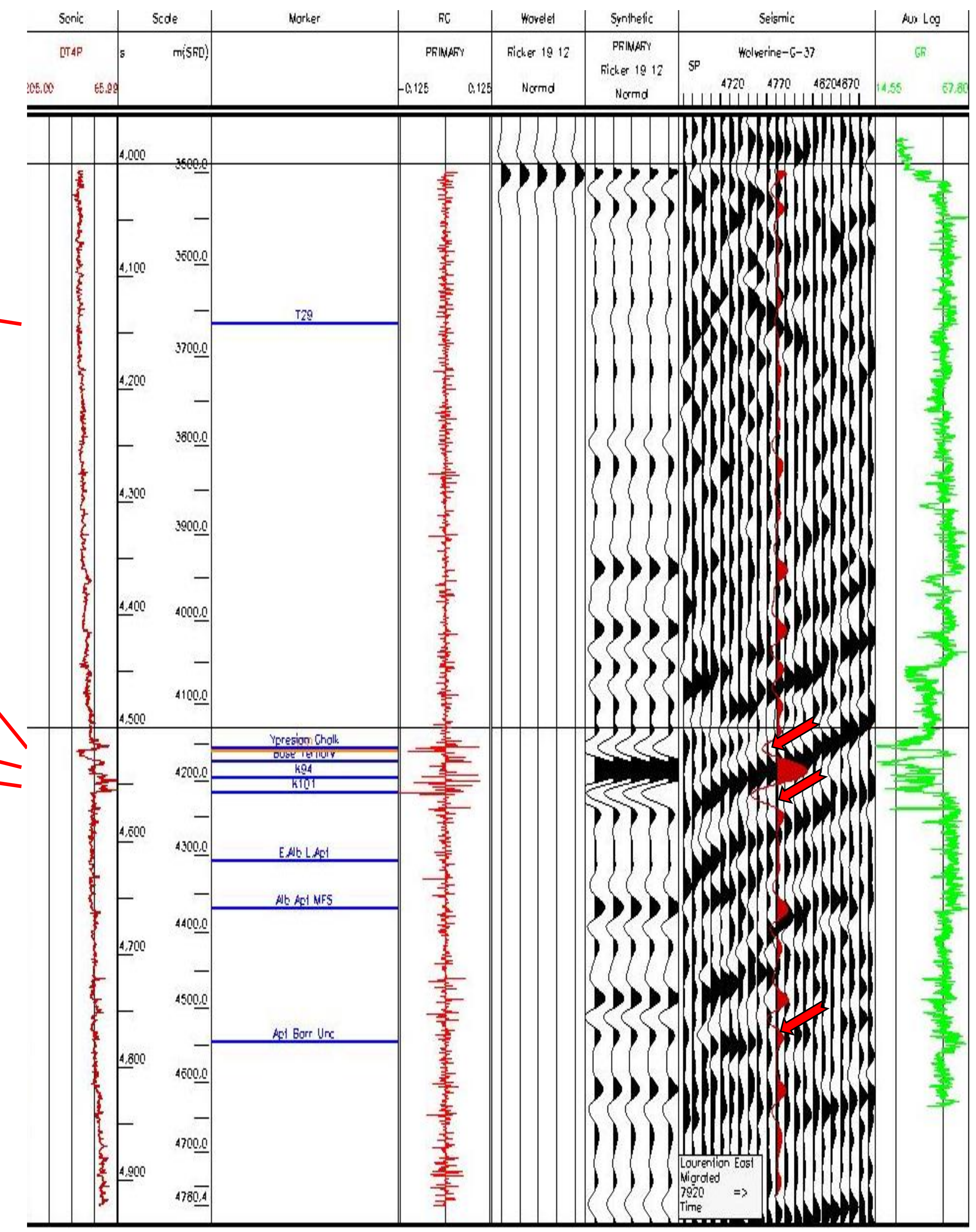
Age (Ma)	Name	ms (TWT)	m (TVDSS)
0	Seabed	124	93
T29	Mid-Oligocene Unc.	1386	1365
T50	Base Ypresian Chalk	Absent	Absent
K94	Turonian/Cenomanian Unc	1710	1867
K101	Late Albian Unc.	1756	1929
K130	Hauterivian MFS	2064	2493
K137	Berriasian/Valanginian Unc	2162	2619
J150	Near Tithonian MFS	Absent	Absent
J163	Near Callovian MFS	2260	2785
	Post Rift Base	4936	Not reached

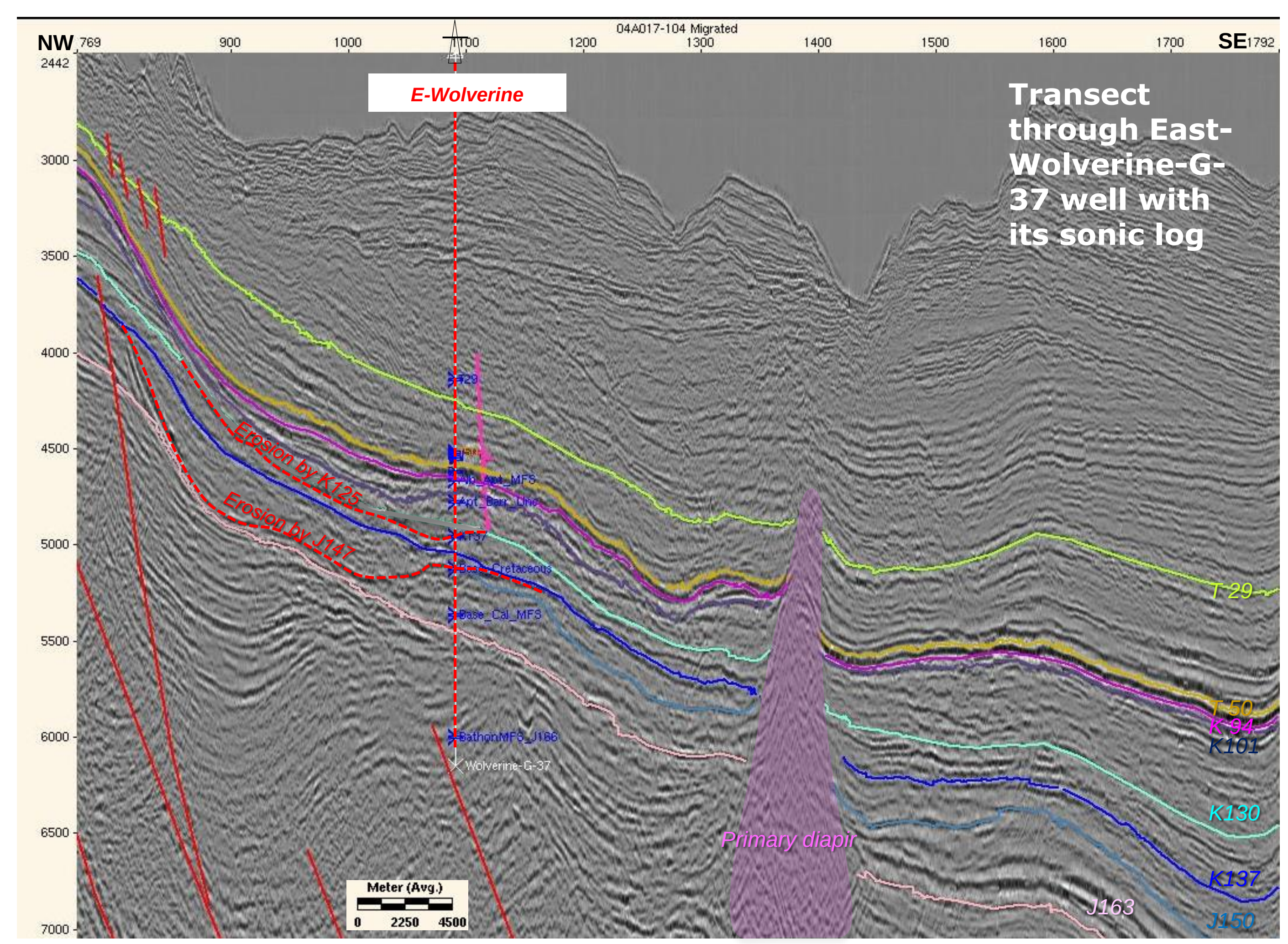


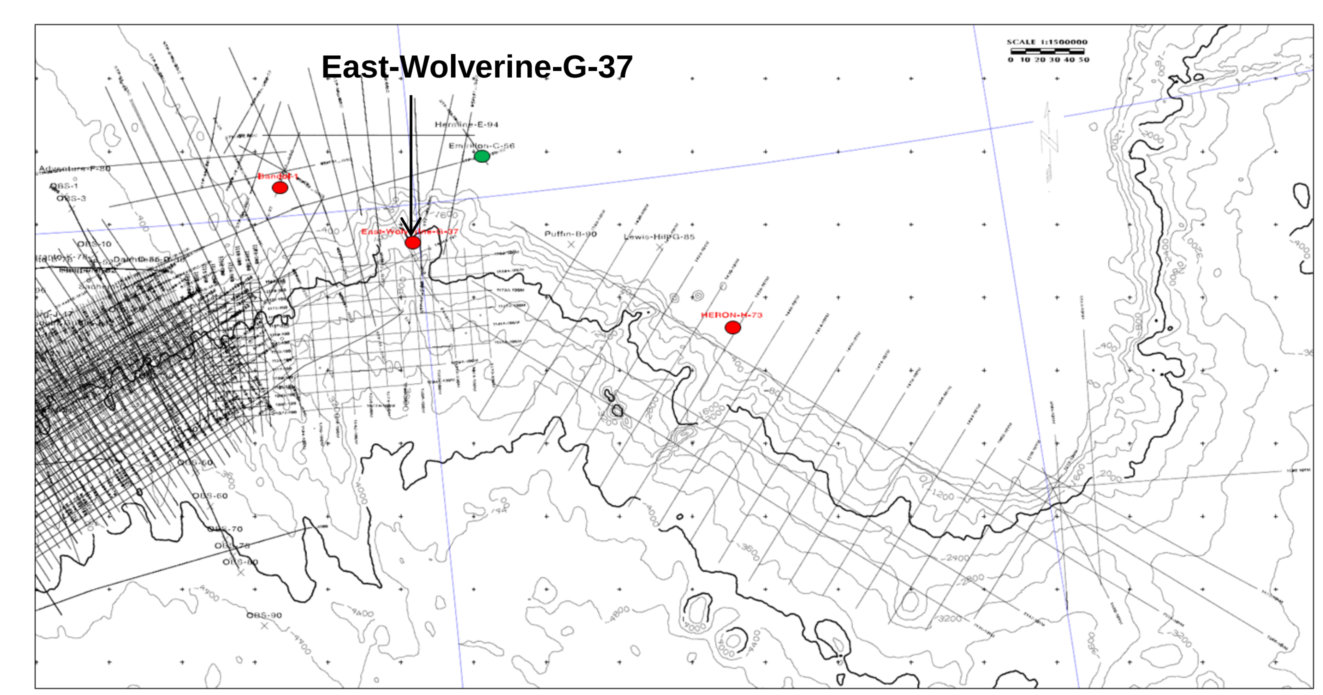
SEISMIC INTERPRETATION – SEISMIC CALIBRATION

Laurentian sub-basin study - CANADA – June 2014









WELL HEADER

Well Name	East-Wolverine-G-37
Rotary Table (R.T.)	31,6 m
Total Depth (T.D.)	6857 m
UTM coordinates @surface (Zone 20N, NAD27, CL66)	X: 1126481 Y: 4988092

BIOSTRATIGRAPHY

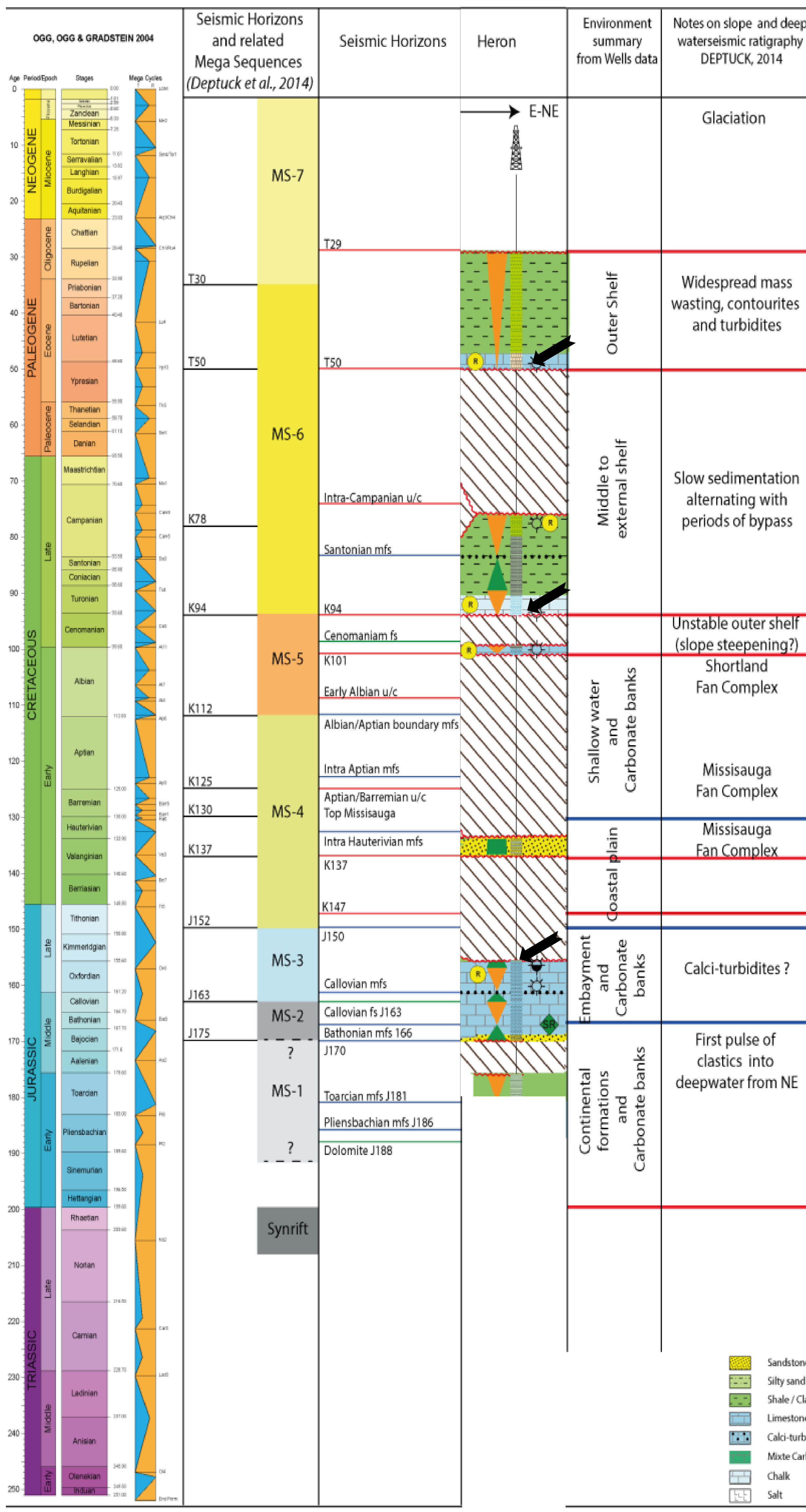
RPS Energy 2014

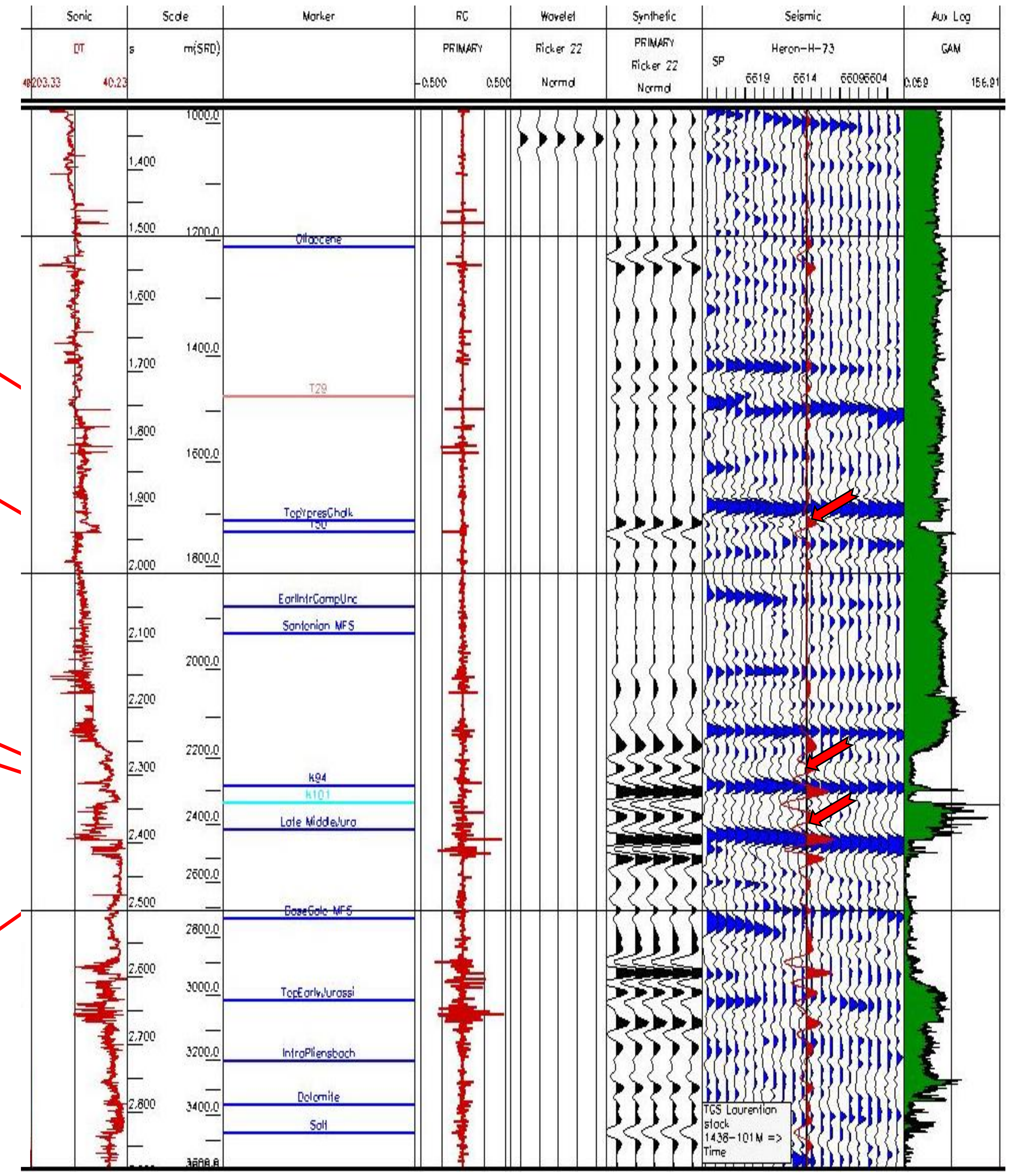
SEISMIC LOCATION

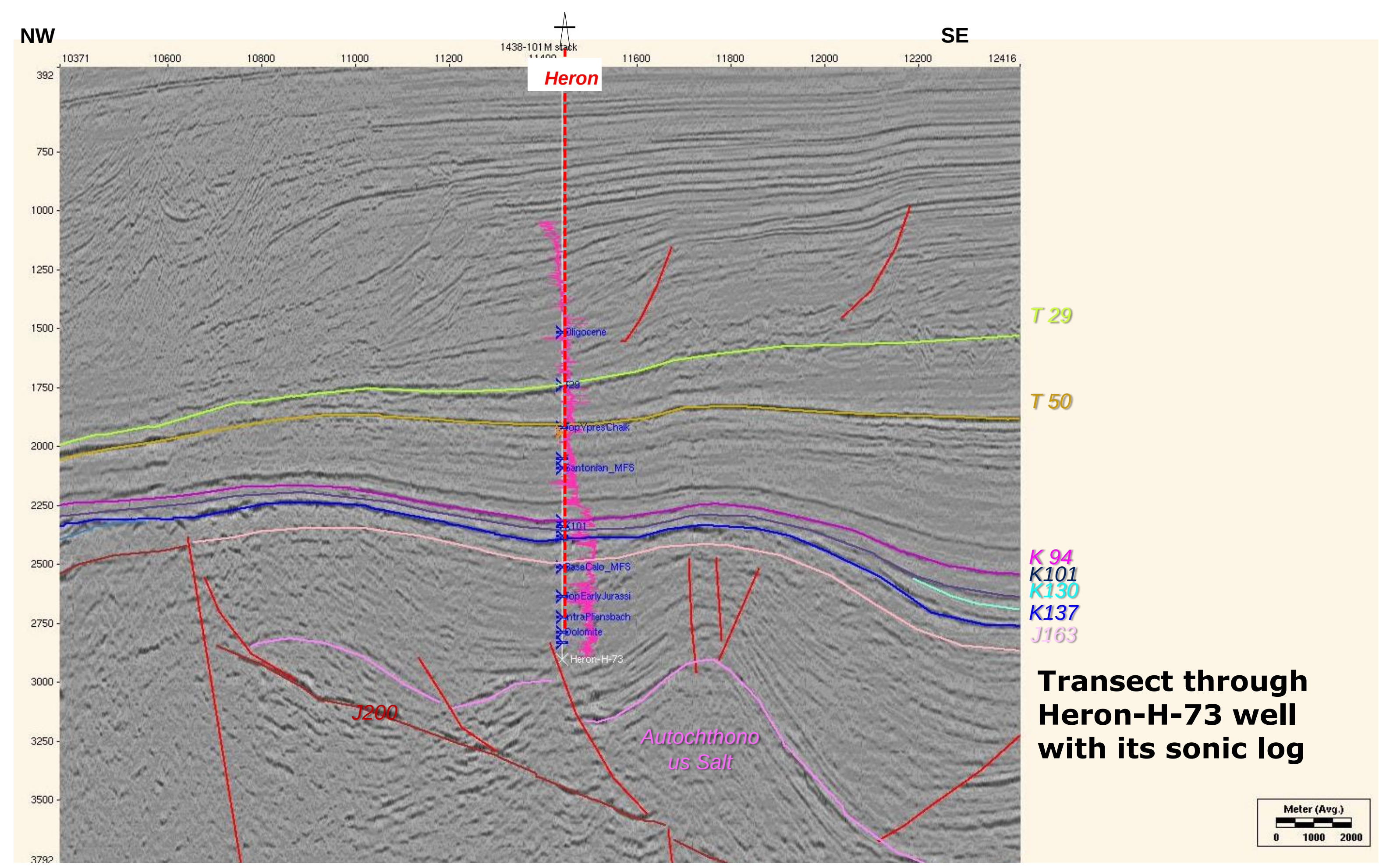
Survey	Laurentian_East
Line	7920
SP	4770
Time shift (ms)	120

SEISMIC MARKERS

Age (Ma)	Name	ms (TWT)	m (TVDSS)
0	Seabed	2544	1890
T29	Mid-Oligocene Unc.	4152	3663
T50	Base Ypresian Chalk	4500	4161
K94	Turonian/Cenomanian Unc	4554	4195
K101	Late Albian Unc.	4590	4218
K130	Hauterivian MFS	Absent	Absent
K137	Berriasian/Valanginian Unc	4956	4835
J150	Near Tithonian MFS	Absent	Absent
J163	Near Callovian MFS	5370	5518
	Post Rift Base	8208	Not reached







WELL HEADER

Well Name	Heron-H-73
Kelly Bushing (K.B.)	25,9 m
Total Depth (T.D.)	3632 m
UTM coordinates @surface (Zone 20N, NAD27, CL66)	X: 1347195 Y: 4930834

BIOSTRATIGRAPHY

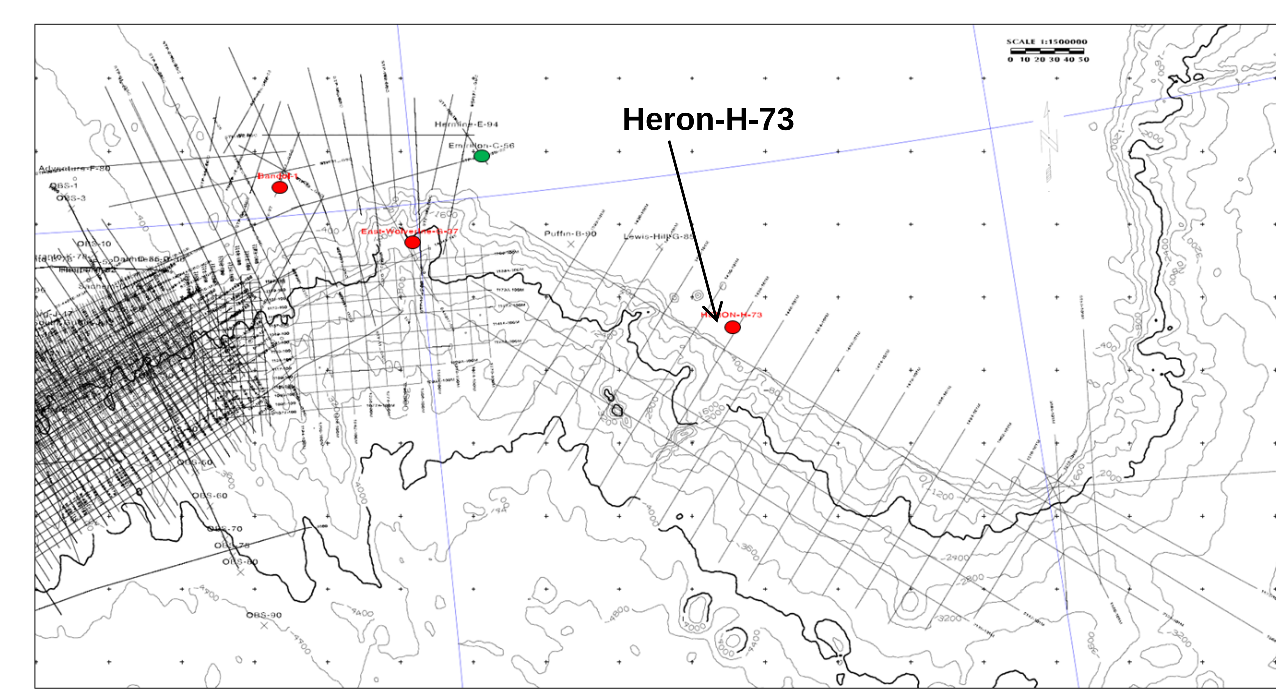
RPS Energy 2014

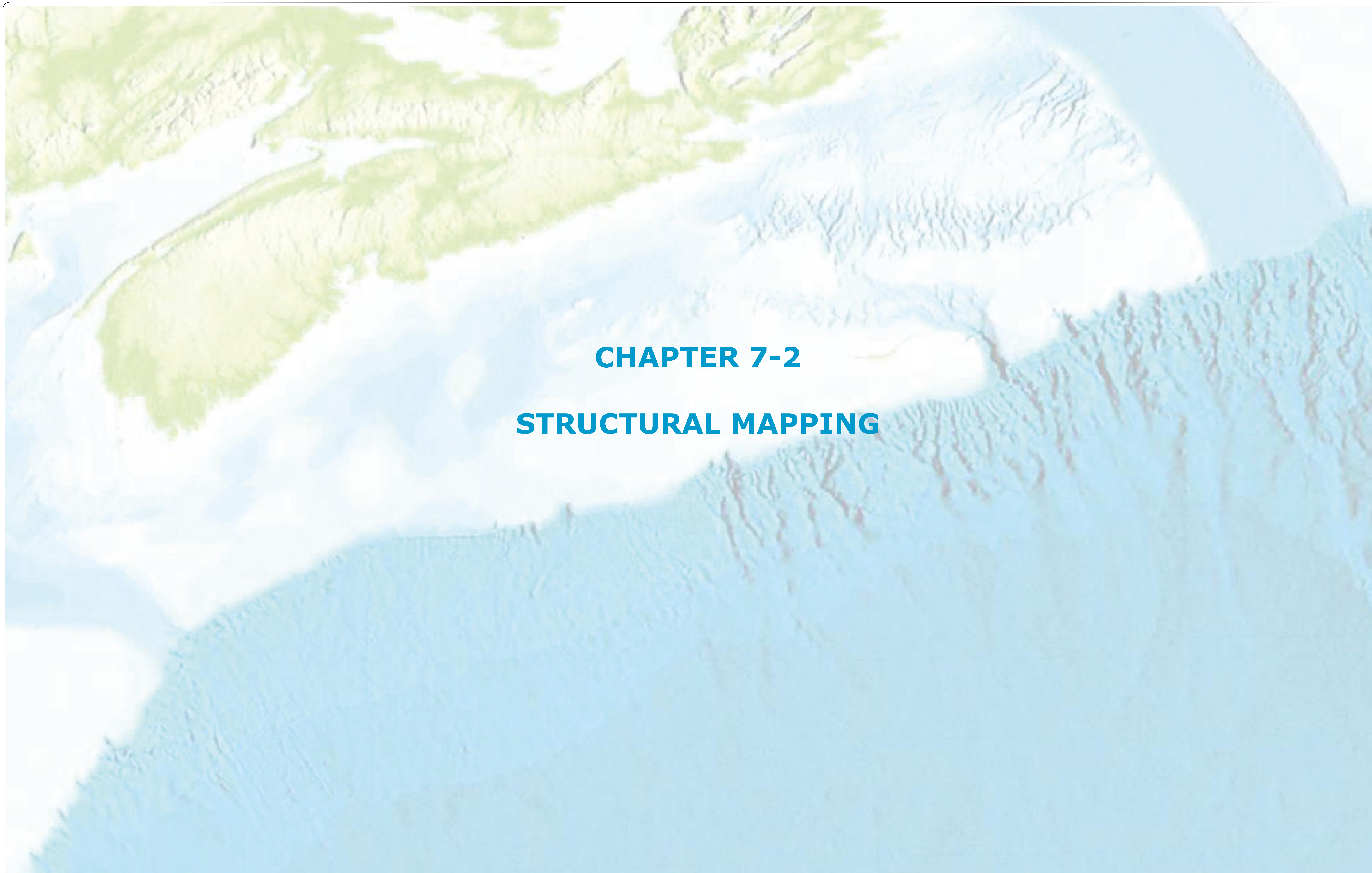
SEISMIC LOCATION

Survey	TGS_Laurentian (Batch 2)
Line	1438-101M
SP	5514
Time shift (ms)	386

SEISMIC MARKERS

Age (Ma)	Name	ms (TWT)	m (TVDSS)
0	Seabed	186	140
T29	Mid-Oligocene Unc.	1740	1476
T50	Base Ypresian Chalk	1908	1739
K94	Turonian/Cenomanian Unc	2318	2290
K101	Late Albian Unc.	2356	2345
K130	Hauterivian MFS	Absent	Absent
K137	Berriasian/Valanginian Unc	2398	2434
J150	Near Tithonian MFS	Absent	Absent
J163	Near Callovian MFS	2506	2765
	Post Rift Base	3456	Not reached





CHAPTER 7-2

STRUCTURAL MAPPING

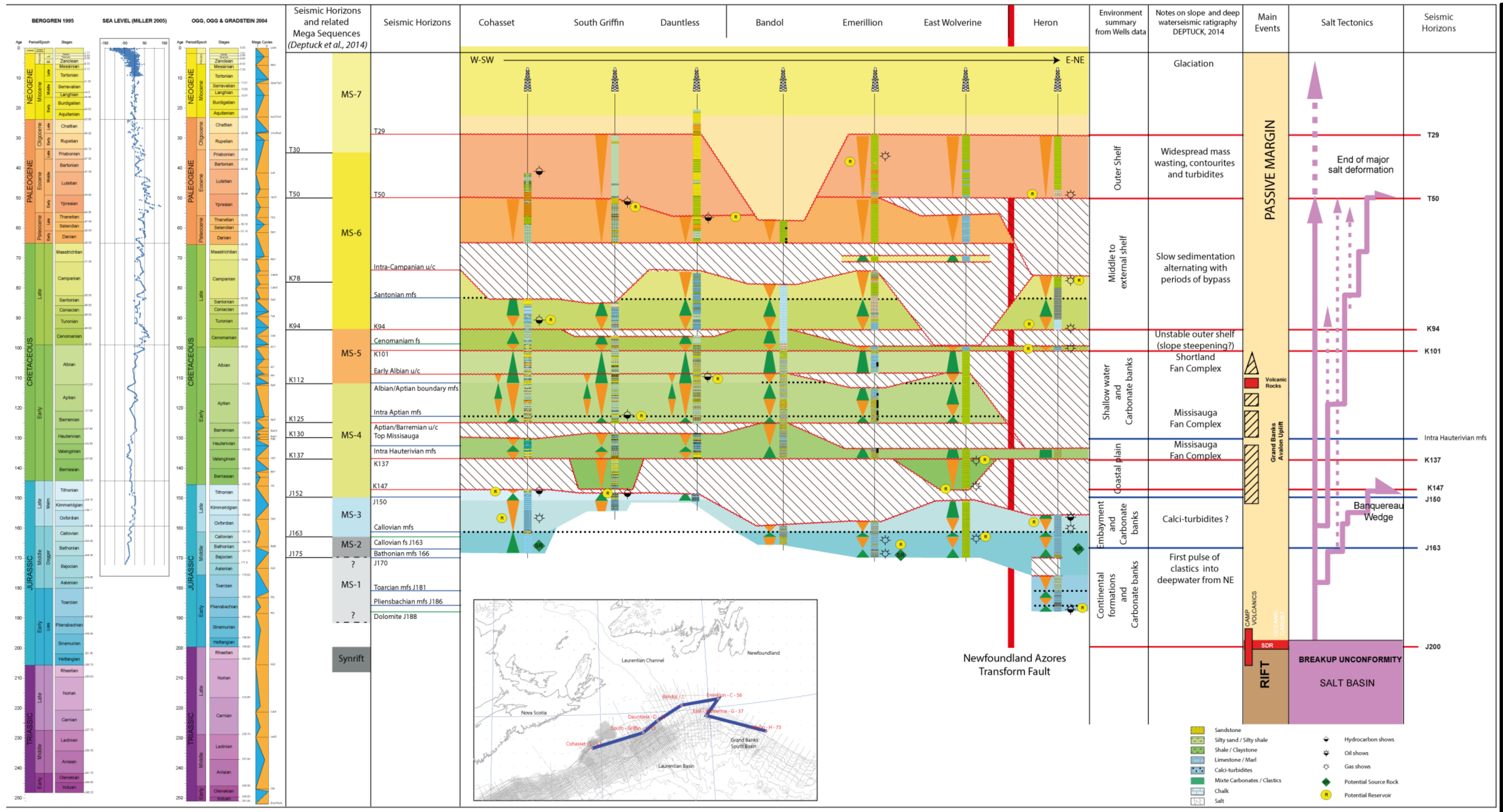


Figure 1 : Tectono-stratigraphical chart for the Nova Scotia – Laurentian Sub-Basins.

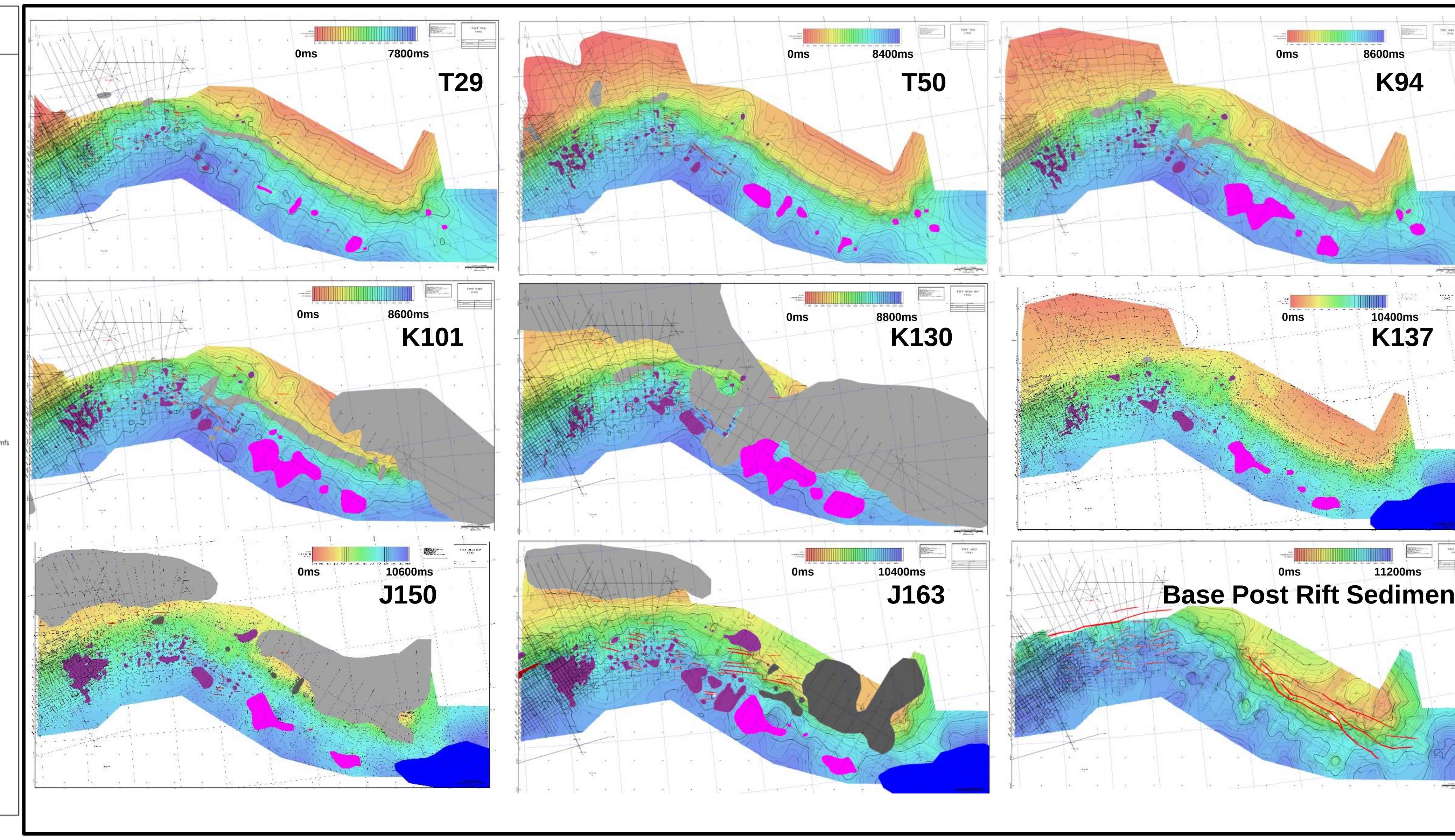
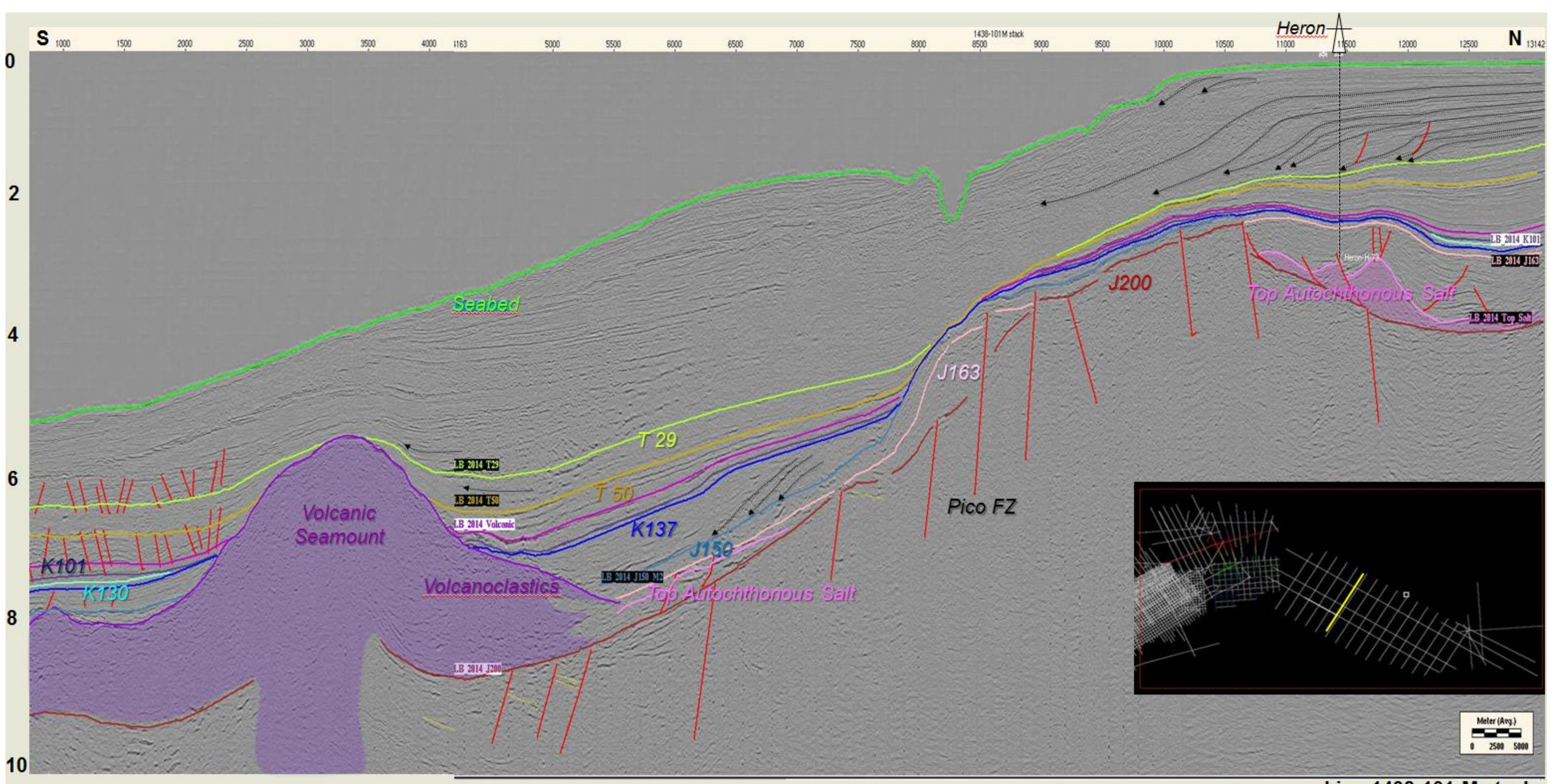


Figure 2 : TWT maps of the nine interpreted horizons (See TWT maps in attachment in full size resolution)



breakdown (Pico Fault Zone), and the occurrence of autochthonous salt and volcanic seamount.

The results of the biostratigraphy study in parallel with the well-to-seismic tying and the seismic interpretation of isochronous surfaces constrained the identification of several key surfaces, in agreement with the Play Fairway Analysis of the Nova Scotia Project. In total 9 horizons were regionally mapped over the Laurentian Sub-Basin, the South Whale Basin and the Western Grand Banks in TWT (Two-Way-Time) domain. They are from top to bottom:

1. T29 (Mid Oligocene Unconformity)
2. T50 (Base Ypresian Chalk)
3. K94 (Cenomanian Turonian Unconformity)
4. K101 (Late Albian Unconformity)
5. K130 (Hauterivian MFS)
6. K137 (Berriasian / Valanginian Unconformity)
7. J150 (Near Tithonian MFS)
8. J163 (Near Callovian MFS)
9. Base of Post-Rift sediment

Additional seismic horizons were regionally or locally picked to better understand the salt deformation (tops of autochthonous and allochthonous salt), to better constrain the time-to-depth conversion (Seabed), and to image the seamounts close to the Western Grand Banks (top of volcanic rocks).

The faults were interpreted on seismic cross-sections and laterally correlated to define the fault network of the different stratigraphic units. The same process has been applied to the salt diapirs, volcanic seamounts and erosion areas.

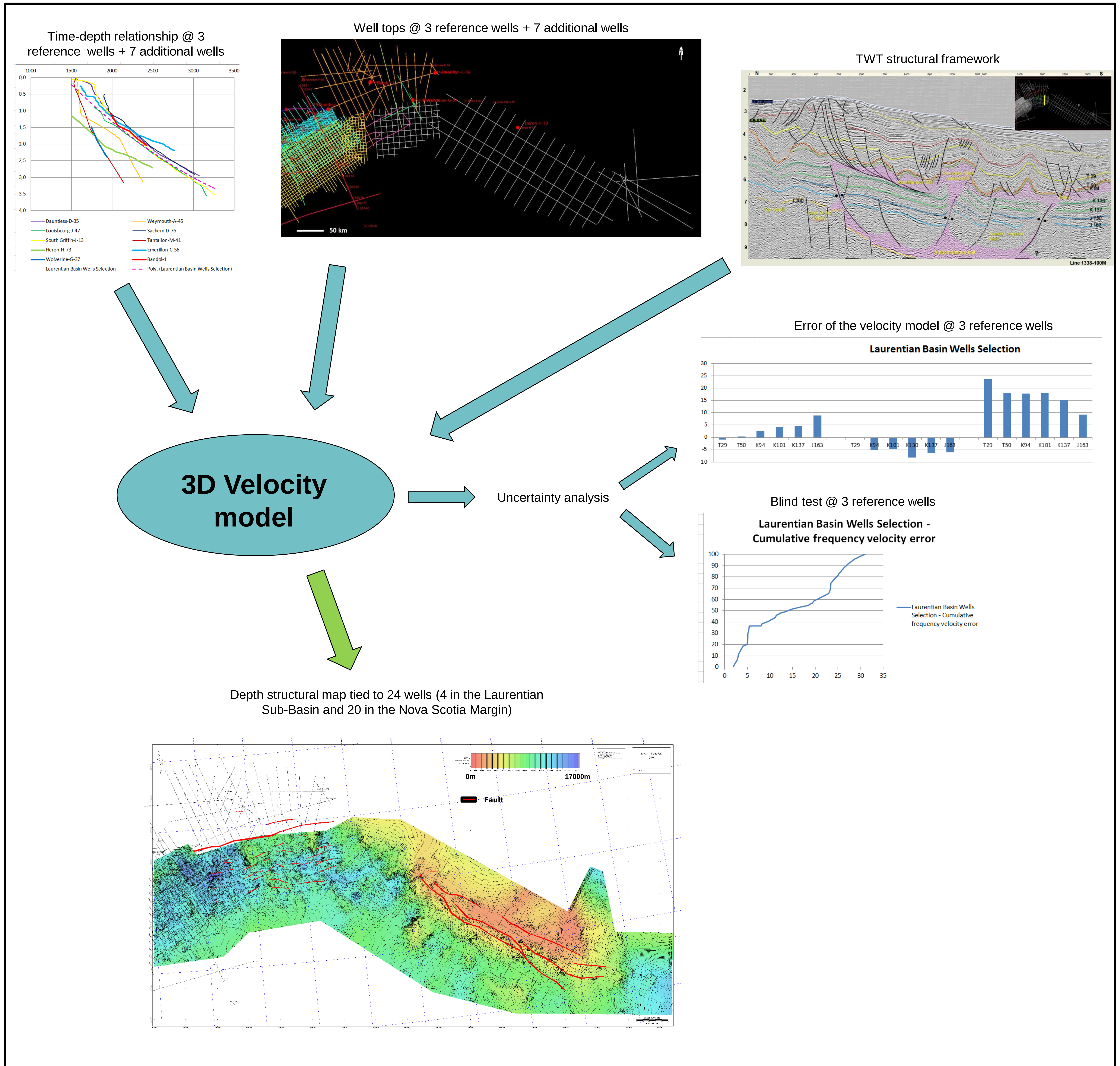


Figure 1 : Time-to-depth conversion workflow with its uncertainty analysis

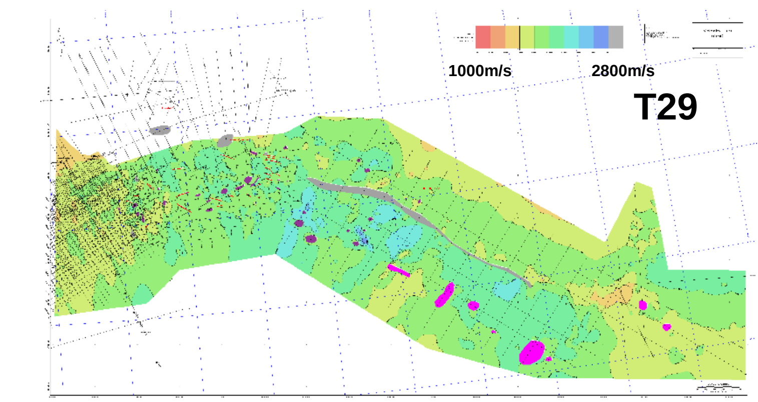
A 3D velocity model was built on the Laurentian Sub-Basin, the South Whale Basin and the Western Grand Banks to depth convert the TWT surfaces resulting from the seismic interpretation of 2D seismic dataset.
Time-depth relationships from the calibration step were used to constrain the time to depth conversion from Western Grand Banks till the Nova Scotia Margin :

- from the 3 reference wells (Bandol-1, East-Wolverine-G-37 and Heron-H-73)
- from an additional well in the Laurentian Sub-Basin (Emerillon-C-56)
- from six wells in the Nova Scotia Margin to better constrain the velocity model (Tantallon-M-41, Weymouth-A-45, Louisbourg-J-47, South Griffin-J-13, Dauntless-D-35 and Sachem-D-76).

The well tops for the 3 reference wells of the studied area allow to control the velocity law at each interpreted horizon, and to estimate and predict the velocity error.

The final depth maps tie to the geological tops of the 3 reference wells, 1 additional well in the Laurentian Sub-Basin and 20 additional wells (2011 Play Fairway Analysis Project) in the Nova Scotia margin. They are from top to bottom:

1. T29 (Mid Oligocene Unconformity)
2. T50 (Base Ypresian Chalk)
3. K94 (Cenomanian Turonian Unconformity)
4. K101 (Late Albian Unconformity)
5. K130 (Hauterivian MFS)
6. K137 (Berriasian / Valanginian Unconformity)
7. J150 (Near Tithonian MFS)
8. J163 (Near Callovian MFS)
9. Base of Post-Rift sediment (J200)



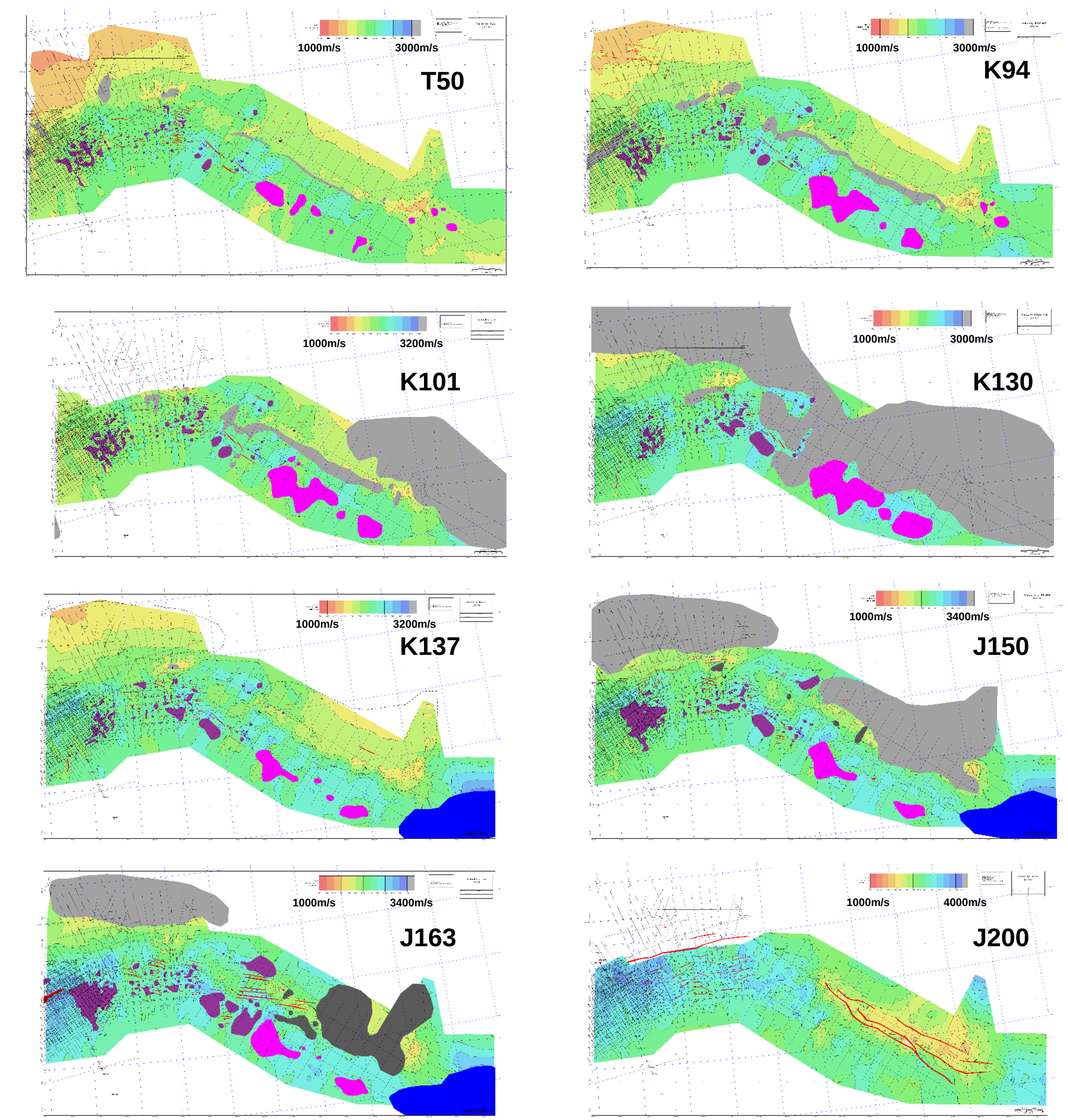


Figure 2 : Interval velocity (between the seabed and the considered horizon) maps of the 9 interpreted horizons (See Velocity maps in attachment in full size resolution)

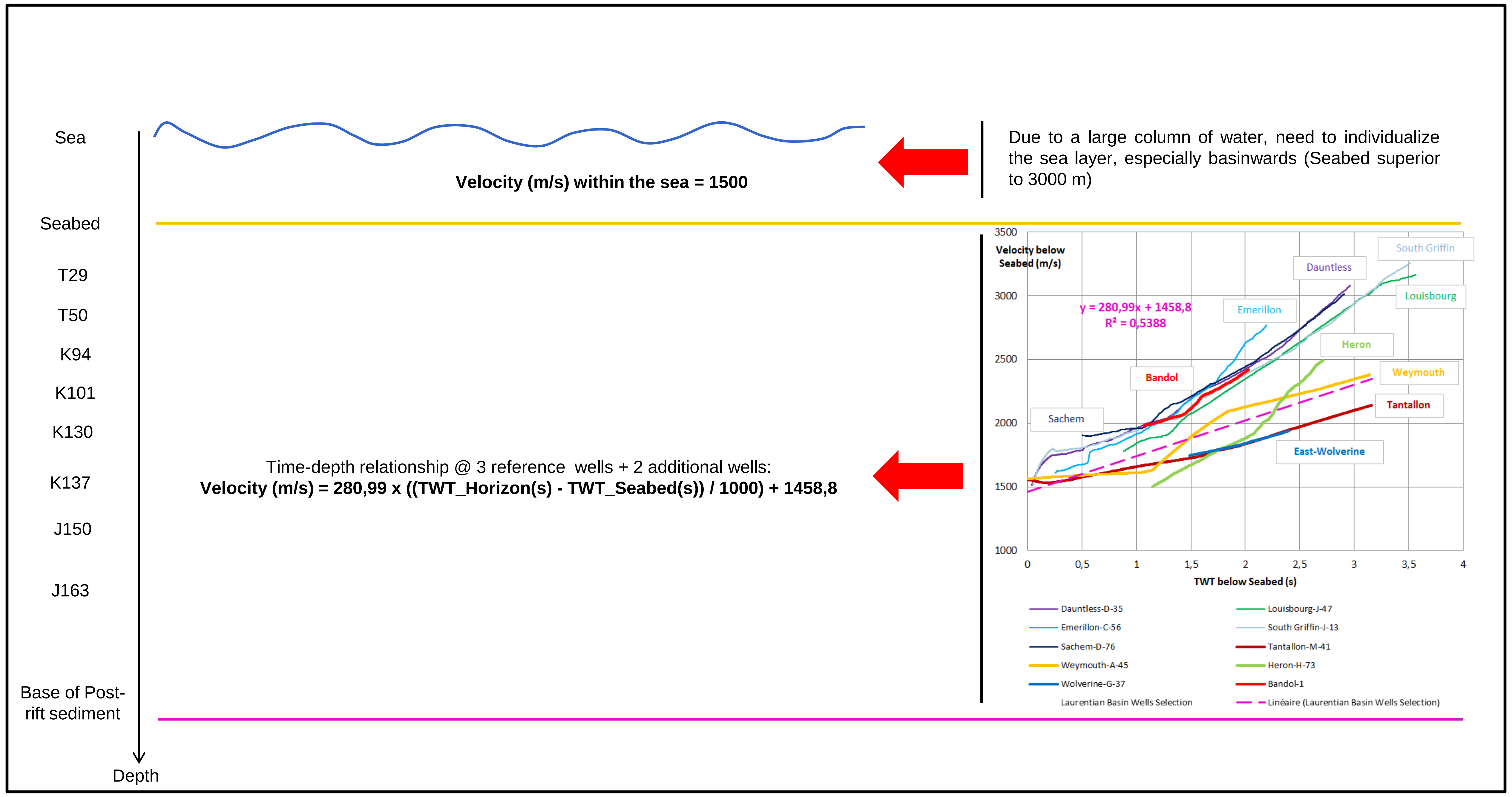


Figure 1 : Velocity model for the time-to-depth conversion on the Laurentian Sub-Basin, the South Whale Basin and the Western Grand Banks. Three layers have been identified to compute interval velocities. On the right are listed the reasons of these layers

The structural mapping is divided into 3 geographical parts:

- the Laurentian Basin, South Whale Basin and Western Grand Banks of Newfoundland, interpreted by Beicip-Franlab / CNSOPB/RPS in 2014;
- the Nova Scotia Margin, interpreted by Beicip-Franlab/RPS in 2011.

The time-to-depth conversion of the Nova Scotia Margin integrates seismic velocities from the 2010 reprocessed GXT-Novaspan and TGS 2D lines, which were not available for the Laurentian Sub-Basin, the South Whale Basin and the Western Grand Banks. In order not to have any "merge print" on depth maps, Nova Scotia TWT interpreted maps have been merged with the Laurentian Sub-Basin, the South Whale Basin and the Western Grand Banks TWT interpreted maps. The same velocity law has been applied for both areas with a new time-to-depth conversion model. The previous velocity model from the PFA 2011 study was not defined in the Laurentian Sub-Basin, and could not be extrapolated and used in this area. It uses three wells in the Laurentian Sub-Basin, the South Whale Basin and the Western Grand Banks, and incorporated two wells in the Nova Scotia Margin in order to integrate the variation on the whole area.

The velocity model consists in two layers (Figure 1):

- the water column at a constant velocity of 1500 m/s;
- between the Seabed to the horizon J200 included, it corresponds to a linear equation based on the analysis of the time-depth relationships computed during the calibration step (PFA 2011 and 2014 study) of the ten wells Bandol-1, East-Wolverine-G-37, Heron-H-73, Emerillon-C-56, Tantallon-M-41, Weymouth-A-45, Louisbourg-J-47, South Griffin-J-13, Dauntless-D-35 and Sachem-D-76. Out of these ten wells, only five have been retained to compute the new velocity model: Bandol-1, East-Wolverine-G-37, Heron-H-73, Tantallon-M-41, Weymouth-A-45. They correspond to:
  - the basin part of the margin, which is more consistent with the Laurentian Sub-Basin than including wells from the platform area;
  - the two wells from the Nova Scotia Margin (Tantallon-M-41, Weymouth-A-45) have been chosen to be structurally coherent with the Laurentian Sub-Basin.

An uncertainty analysis has been carried on in order to estimate the difference (in %) between the average velocity from the model and the one computed from the well data at Bandol-1, East-Wolverine-G-37, Heron-H-73 (Figure 2). For Bandol-1 and East-Wolverine-G-37, the error is less than ±8%; whereas most of the errors are between 10% and 20% for Heron-H-73. Indeed, the velocity model is less accurate for Heron-H-73 due to a geometrical anisotropy of the velocities on the studied area.
The velocity model has been recomputed three times omitting one of the reference wells each time. It allows controlling the "repeatability" of the velocity model by providing an error prediction along the well as if the well did not exist. The difference (in %) between the predicted average velocity when the well is omitted in the new model and the average pseudo-velocity at the well has been ranked (Figure 3). 50% of the difference are inferior to 15% and 90% are inferior to 26%. The amount of error is due to the few number of reference wells, the high variability of the average velocities according to the location, and the absence of checkshot on the reference wells (well-to-seismic tying more risky).

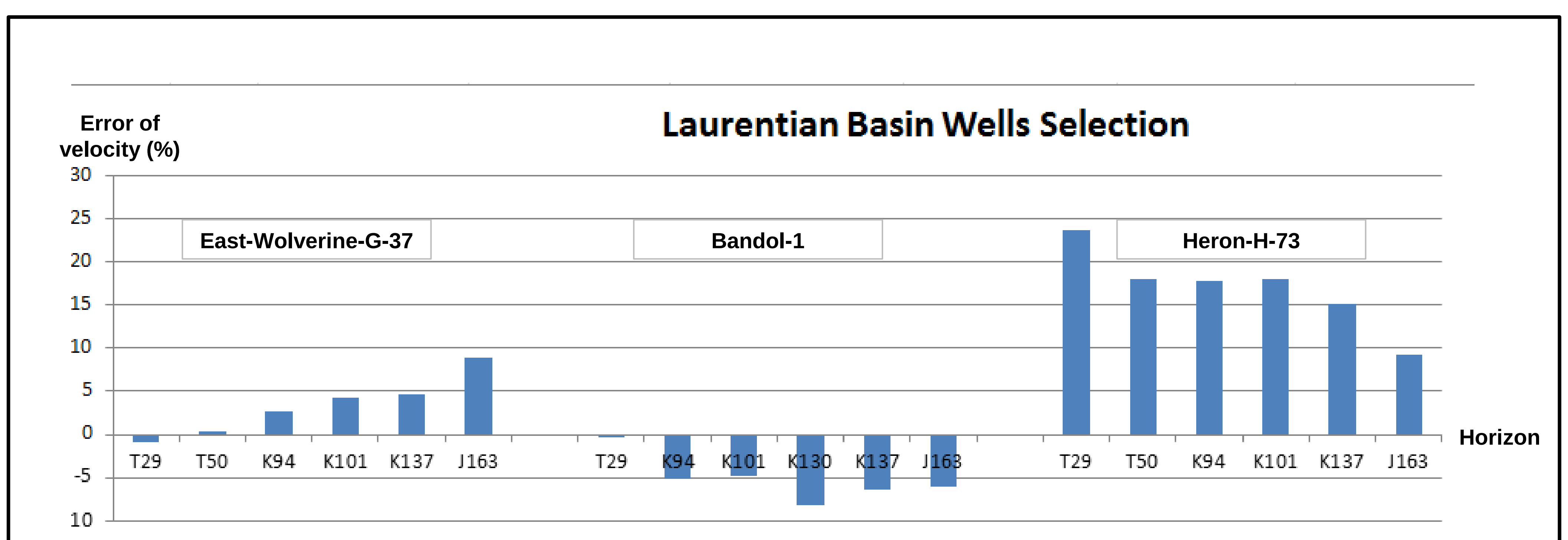


Figure 2 : Uncertainty analysis - Error of the velocity model at the 3 reference wells on the Laurentian Sub-Basin, the South Whale Basin and the Western Grand Banks

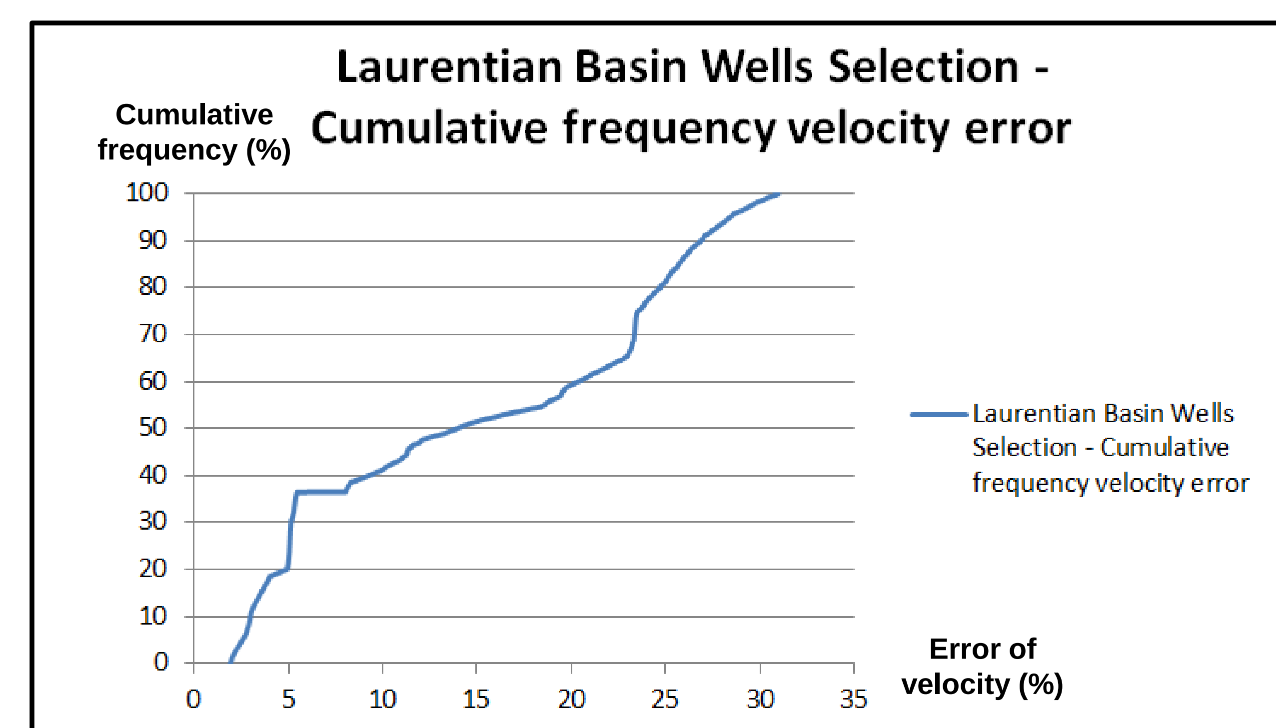


Figure 3 : Uncertainty analysis - Blind test for the 3 reference wells (Bandol-1, East-Wolverine-G-37 and Heron-H-73) on the Laurentian Sub-Basin, the South Whale Basin and the Western Grand Banks. 50% of all the difference computed between the velocity model and the velocity from the well data on the studied area are inferior to 15% (P50 equivalent)

SEISMIC INTERPRETATION – STRUCTURAL MAPPING

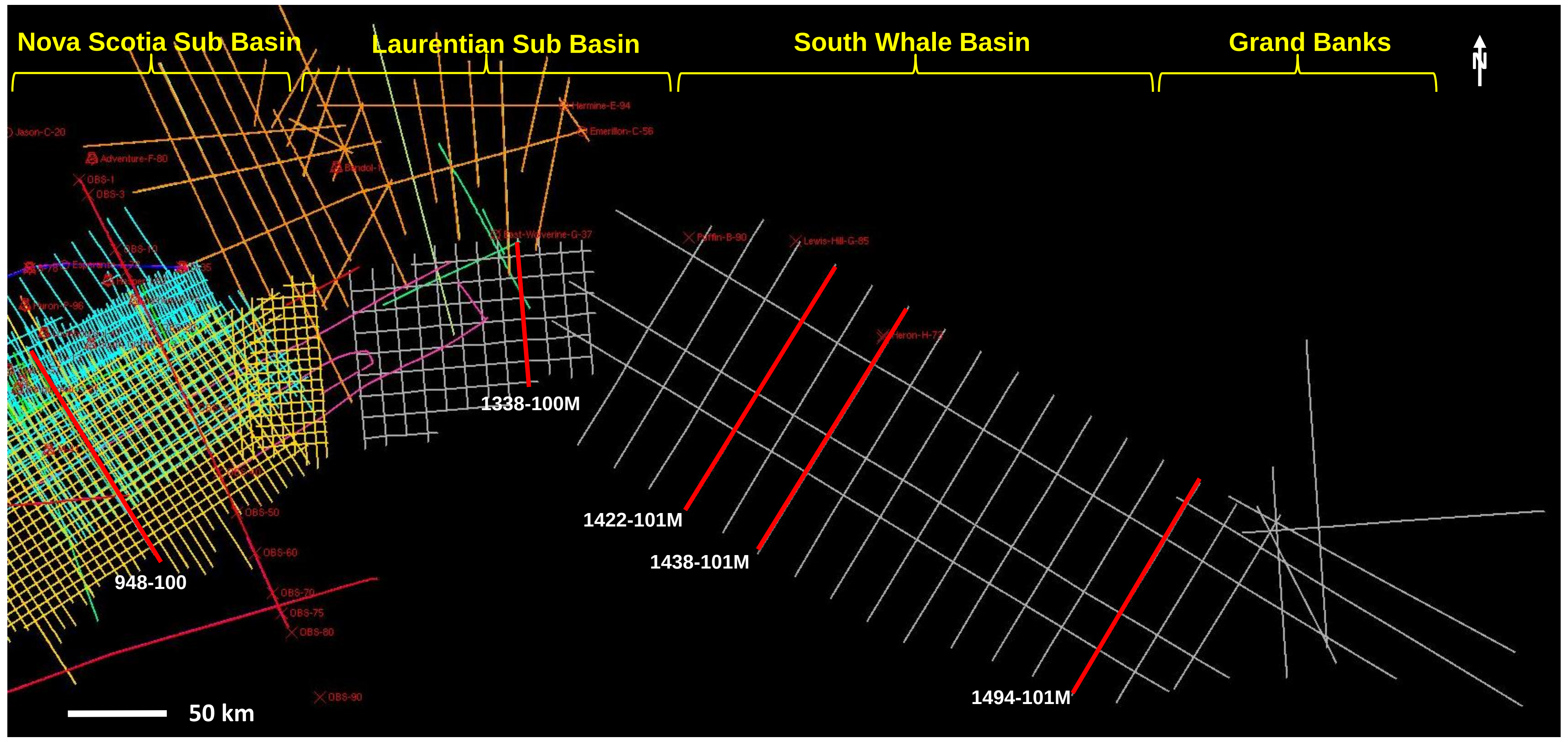


Figure 1 : Location map of the 2D seismic lines illustrating the geological provinces of the studied area: Nova Scotia Margin, Laurentian Sub Basin, South Whale Basin and Grand Banks of Newfoundland

The studied area can be divided in several areas:

- The Nova Scotia Sub Basin and the Laurentian Sub Basin, corresponding to an Atlantic-type volcanic passive margin with salt;
- The South Whale Basin and the Western Grand Banks of Newfoundland, corresponding mainly to a non volcanic transform passive margin, with locally some salt and Early Cretaceous volcanic seamounts (posterior to the Northern Atlantic opening).

The eastern part of the Nova Scotia Margin corresponds to the Banquereau Synkinematic Wedge (Figure 1 and Figure 2). Autochthonous salt from the Huron Sub Basin may have moved southeastward above the South Griffin Ridge, allowing the sliding of the sediments toward the basin. Listric faults developed above this salt (the largest ones are above the South Griffin Ridge). This salt is interpreted to be allochthonous in the basin and its motion may originate some rafts of Jurassic sediments.
The allochthonous salt formed the basal decollement of the Banquereau Synkinematic Wedge, on which all the listric faults are rooted. The motion of the "salt nappe" down the basin is contemporaneous of the synkinematic strata deposited below the salt.

Two levels of salt are identified in the Laurentian Sub-Basin (Figure 1 and Figure 3): an autochthonous salt layer above the faulted "basement" which may have fed a shallower allochthonous salt layer. The autochthonous salt may have been evacuated through regional listric faults and counter-regional faults, on which the horizons K130, K137, J150 and J163 are folded and salt weld are expected.
Listric faults developed on the autochthonous salt sheet and allowed the motion of Cenozoic and Cretaceous sediments (T29, T50 and K94) down the basin. Secondary diapirs seem to have been squeezed by shallow counter-regional listric faults, and it may be the result of the motion of all the sediments southward to the basin.

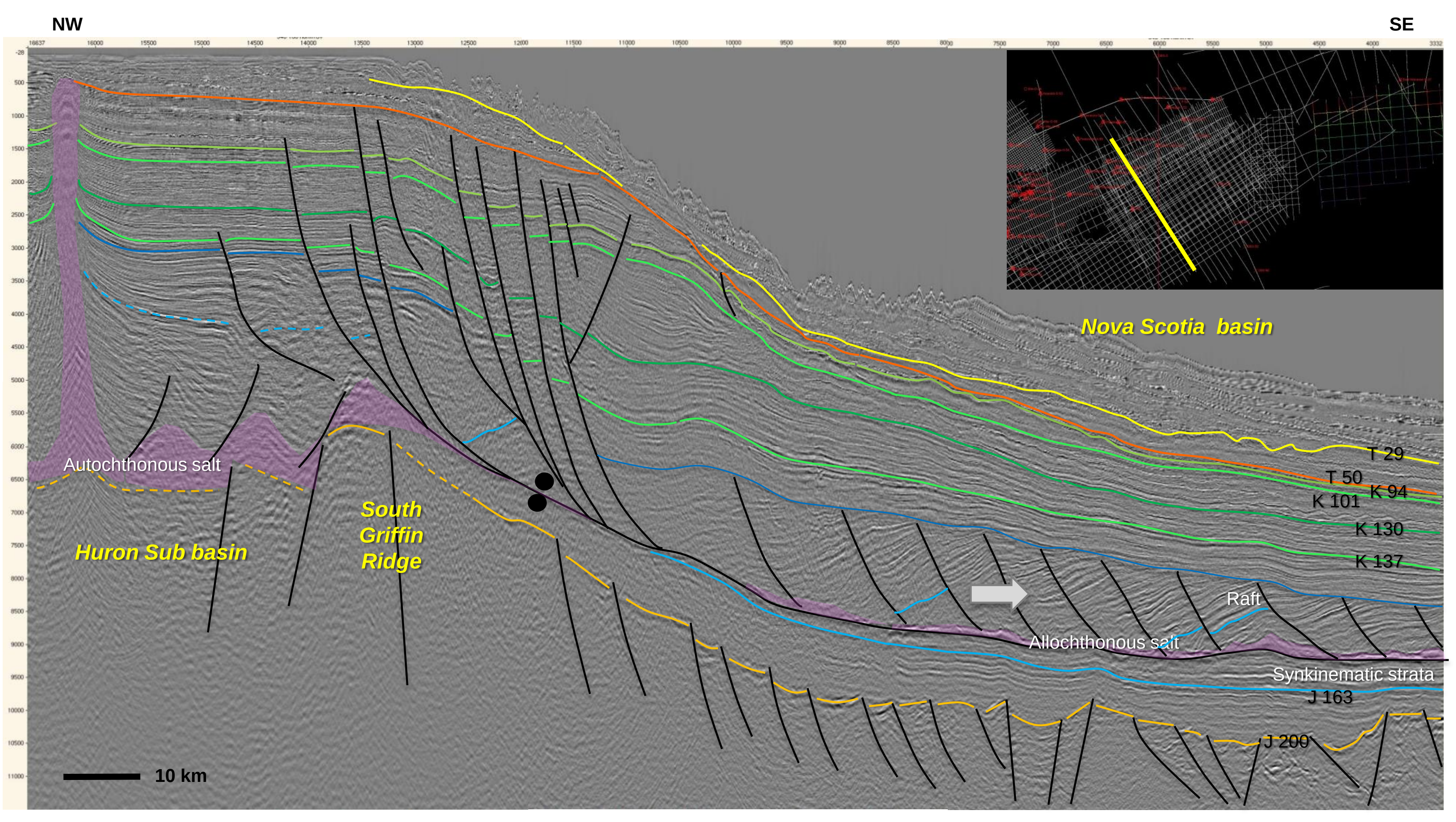


Figure 2 : Seismic section through the Banquereau Synkinematic Wedge. The motion of the salt nappe southward is highlighted, as well as the synkinematic strata deposited below the allochthonous salt

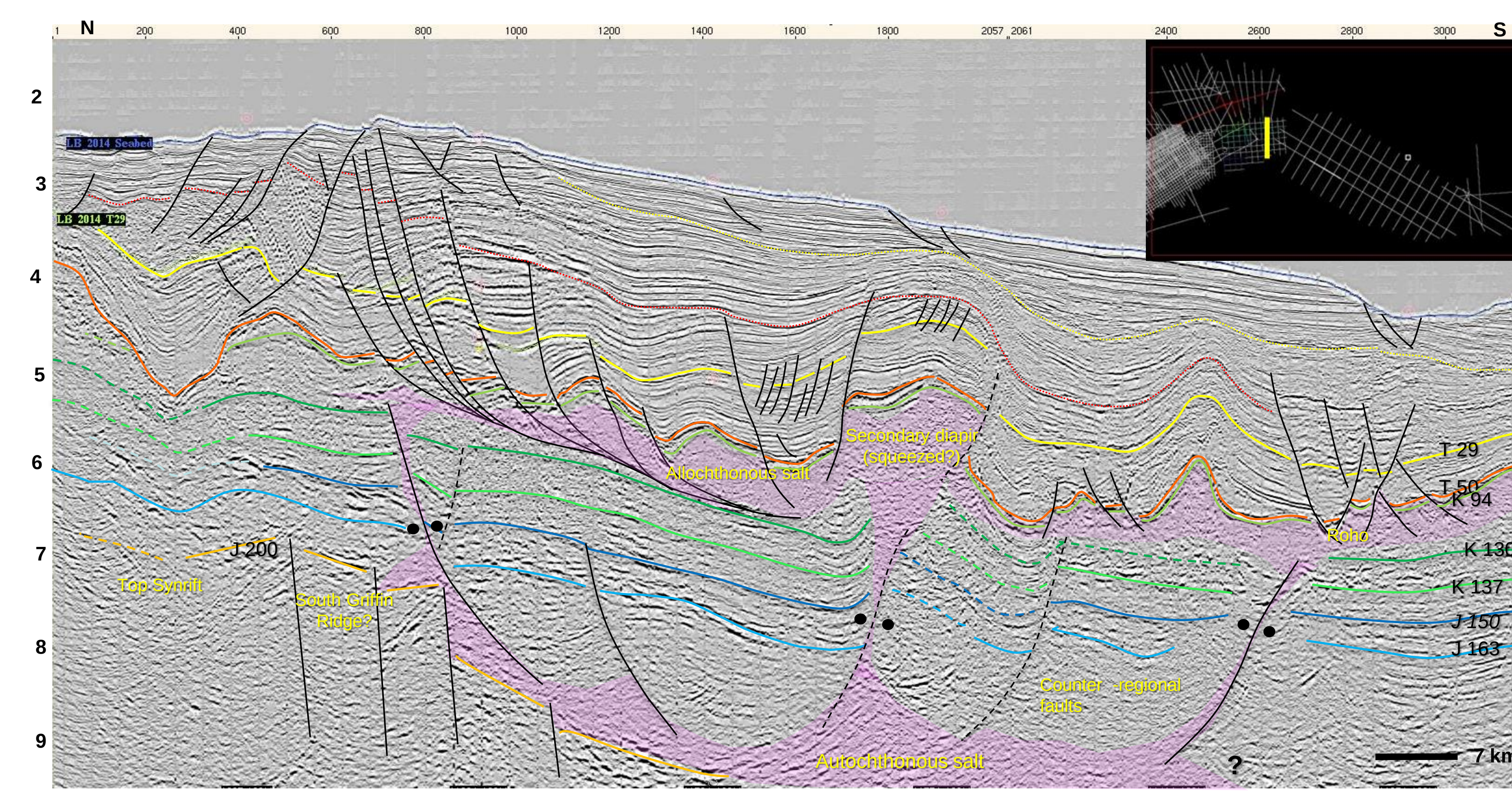


Figure 3 : Seismic section in the Laurentian Sub-Basin. The autochthonous salt is evacuated through counter-regional faults and forms a salt-sheet

The Laurentian Sub Basin extends from the shelf to the South on almost 100 km, and corresponds to the lowest values (in blue) on the gravimetric map (Figure 1). These values are attributed to the salt occurrence, which is well constrained to the North by the slope of the margin and may be delimited to the West by a strike-slip fault associated to the Banquereau Synkinematic Wedge. The Laurentian Sub Basin is also bounded to the Northeast by the Azores Transform Fault Zone (or Newfoundland Fracture Zone), which is highlighted as a prominent lineament on Figure 1.

This discontinuity is interpreted as a highly faulted narrow area on Figure 2. It borders the Newfoundland Ridge and is defined by numerous faults interpreted to affect the rocks until the Conrad Discontinuity (around 10 seconds TWT). The Pico Fault Zone is associated to the Azores Transform Fault Zone.

The South Whale Basin is located on the Southeast of the Laurentian Sub Basin. Only autochthonous salt is interpreted within the basin (Figure 3); its thickness is not well known. Southward, this salt may have been evacuated in a shallower location (allochthonous salt?), and within the basin primary thin diapirs affect all the Cretaceous sediments and partly the Cenozoic layers.
Sediments may originate from the Northeast on the shelf, in which a prograding Cenozoic clastic wedge is highlighted. The Cretaceous sediments are not well developed on the shelf (erosion, bypass?), and the Cenozoic horizons (T29 and T50) eroded the Cretaceous sediments.

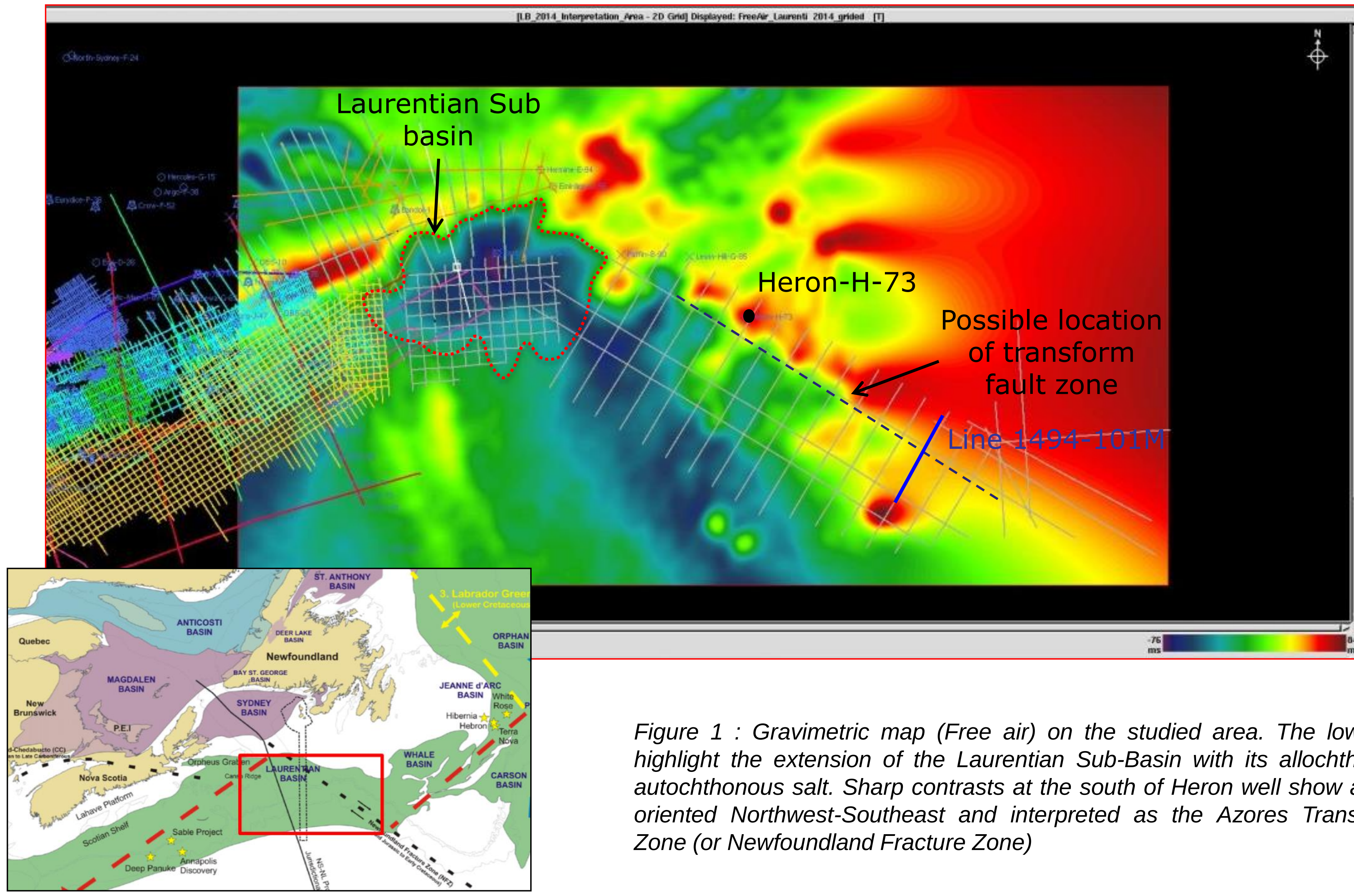


Figure 1 : Gravimetric map (Free air) on the studied area. The lowest values highlight the extension of the Laurentian Sub-Basin with its allochthonous and autochthonous salt. Sharp contrasts at the south of Heron well show a lineament oriented Northwest-Southeast and interpreted as the Azores Transform Fault Zone (or Newfoundland Fracture Zone)

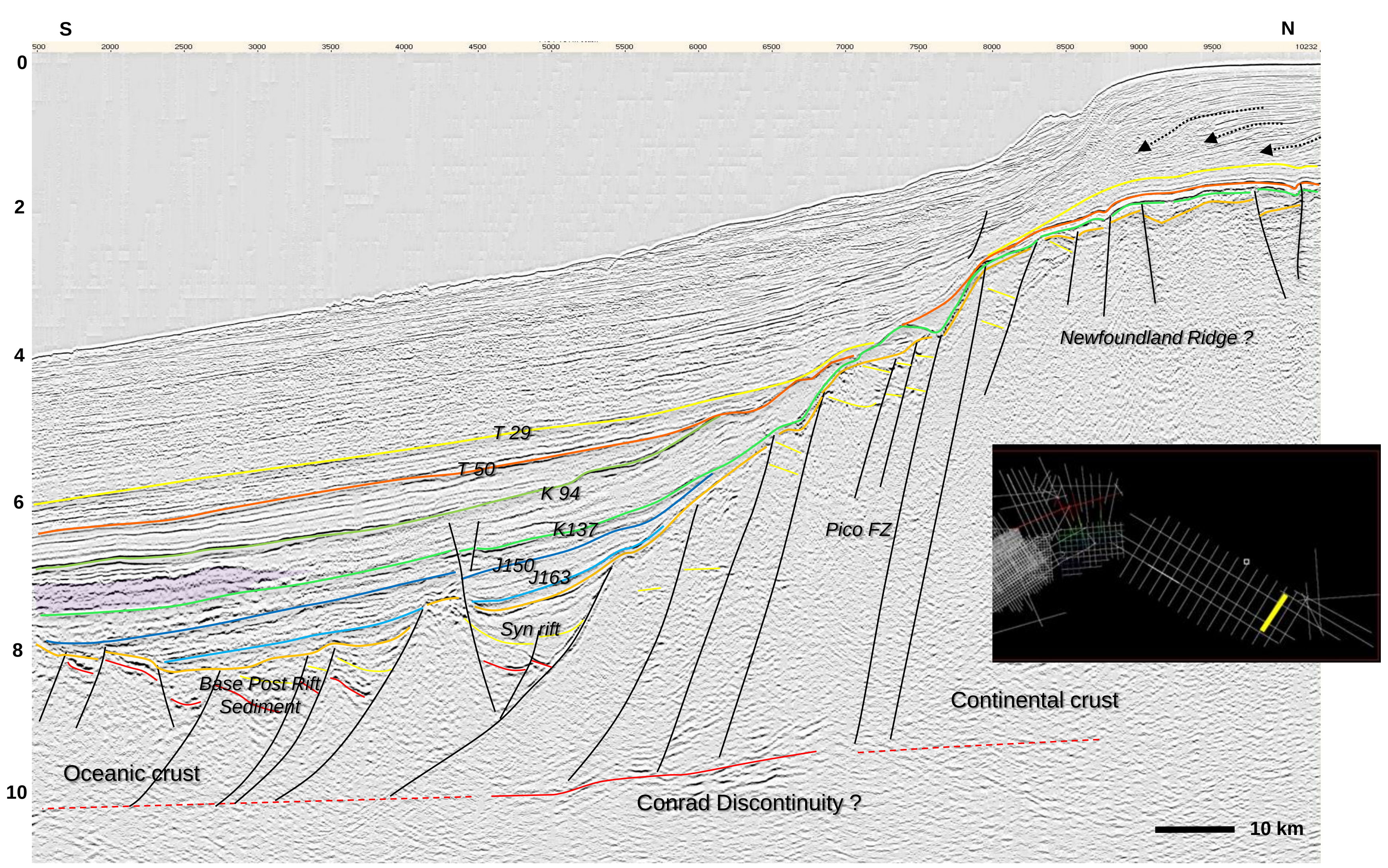


Figure 2 : Seismic section through the Western Grand Banks of Newfoundland. It corresponds to the Volcanic Province, displaying there volcanoclastic interfingering with clastic sediments from the basin. The deep discontinuous reflexions at 10 sec. TWT are attributed to the Conrad Discontinuity

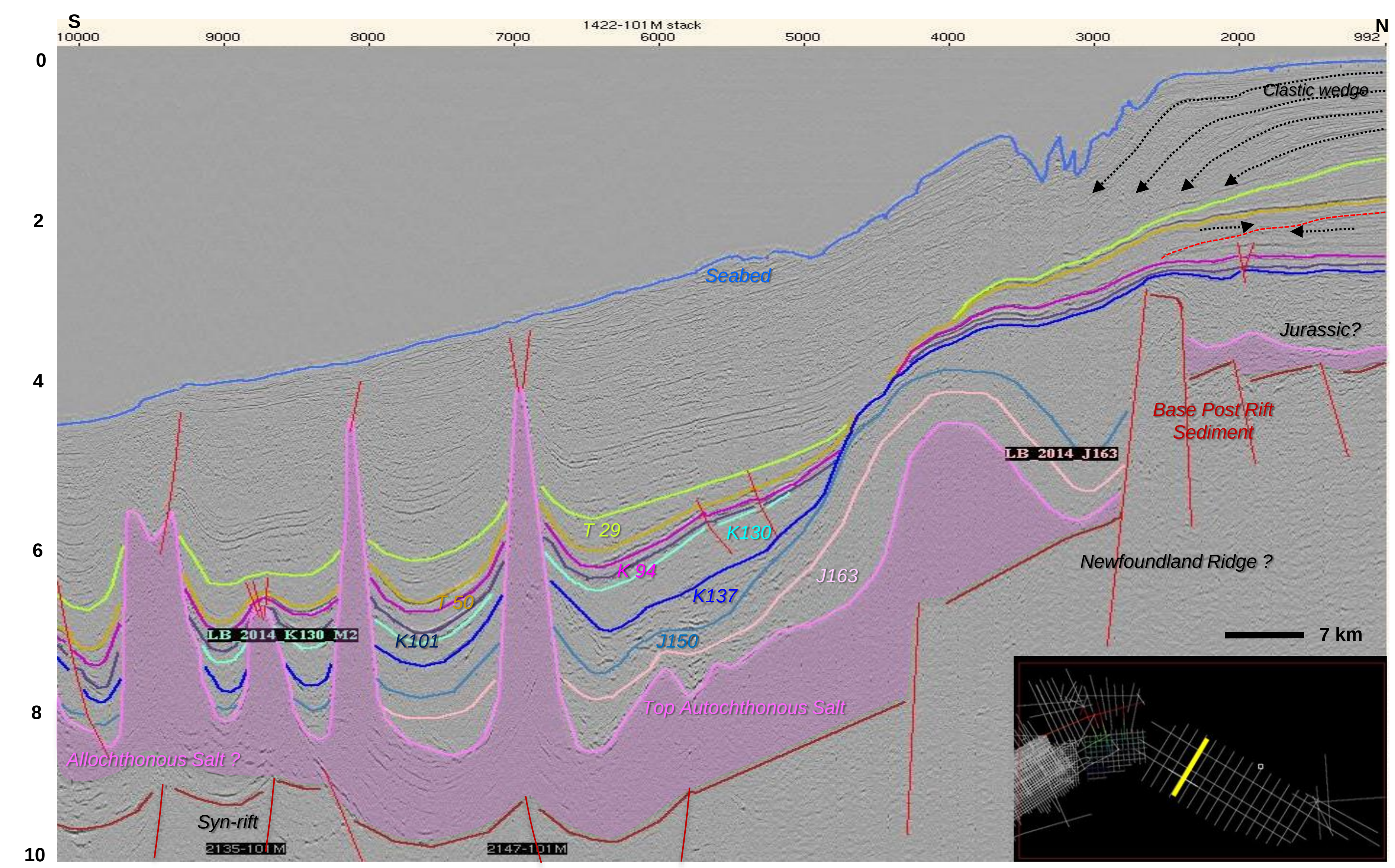


Figure 3 : Seismic section through the South Whale Basin showing the development of the autochthonous salt with its primary diapir in the basin and on the shelf. A prograding Cenozoic clastic wedge is also remarkable on the shelf

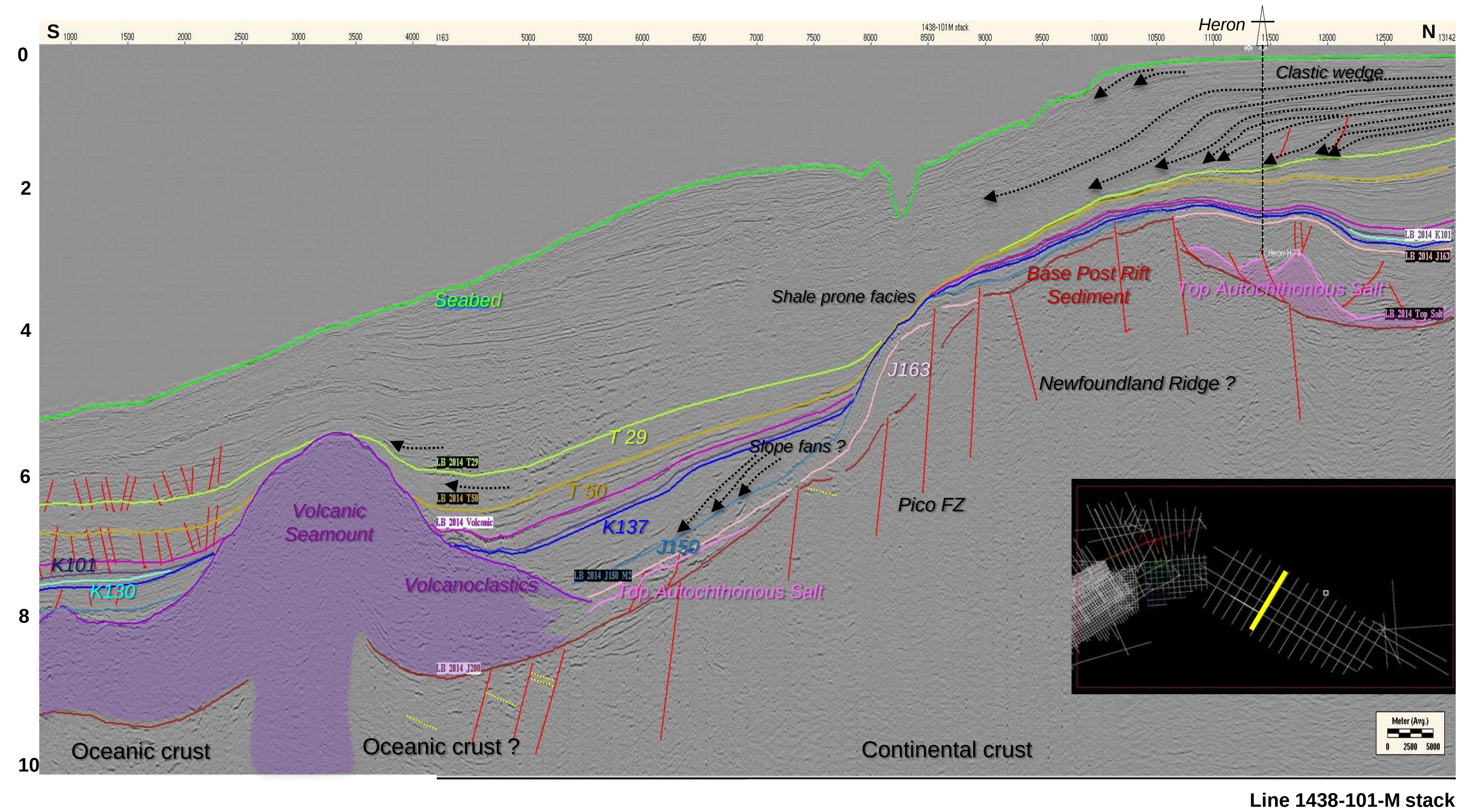


Figure 1 : Seismic section through the Volcanic Province (Western Grand Banks of Newfoundland). An example of volcanic seamount is shown in the basin; it corresponds to one of the Fogo Seamounts. It may be surrounded by volcanoclastics (high amplitude, low continuity reflections). It marks the transition to the "pure" oceanic crust

The easternmost part of the studied area corresponds to the Western Grand Banks of Newfoundland provinces. No salt is encountered in the basin, but seamounts as igneous plugs are highlighted and belong to the Fogo seamounts (Figure 1 and Figure 2). These volcanic plugs are surrounded by volcanoclastics interfingering with the Early Cretaceous (K137) sediments. Cenozoic and Late Cretaceous sediments pinch out on the seamounts, whereas Jurassic (J150 and J163) sediments could have been cut the volcanics.

Northward, the Newfoundland Ridge delimits the main basin from the shelf; on which developed a narrow basin at the Jurassic time with autochthonous salt. This basin centered around Heron-H-73 well is capped by several carbonate platforms developed at different periods (J163, K101 and K94). A thick package corresponding to a Cenozoic clastic wedge (above T29) prograded from the shelf to the main basin.

Four main geologic provinces are encountered in the studied area and highlighted in the previous seismic sections (Figure 2):

- The Banquereau Synkinematic Wedge with its basal allochthonous salt, and its assoiated listric faults and rafts;
- The Autochthonous salt Province located in the Huron Sub Basin and feeding laterally the allochthonous salt of the Banquereau Synkinematic Wedge; and located also in the South Whale Basin leading to primary diapirs;
- The Autochthonous and Allochthonous Salt Province located in the Laurentian Sub Basin linked by regional and counter-regional listric faults;
- The Volcanic Province in the Western Grand Banks of Newfoundland, in which the Fogo Seamounts are highlighted and are related to an Early Cretaceous period.

Faulting related to salt tectonics affects mainly the Late Cretaceous and Cenozoic layers, and depends on diapirs or slope gliding (oriented in this case ENE-WSW to WNW-ESE). Polygonal faults are interpreted in some domal structures above diapirs or in the slope of the basin. The deepest discontinuities associated with the Base Post Rift Sediment are oriented NE-SW in the Laurentian Sub Basin to NW-SE in the South Whale Basin and Western Grand Banks of Newfoundland (Figure 2).

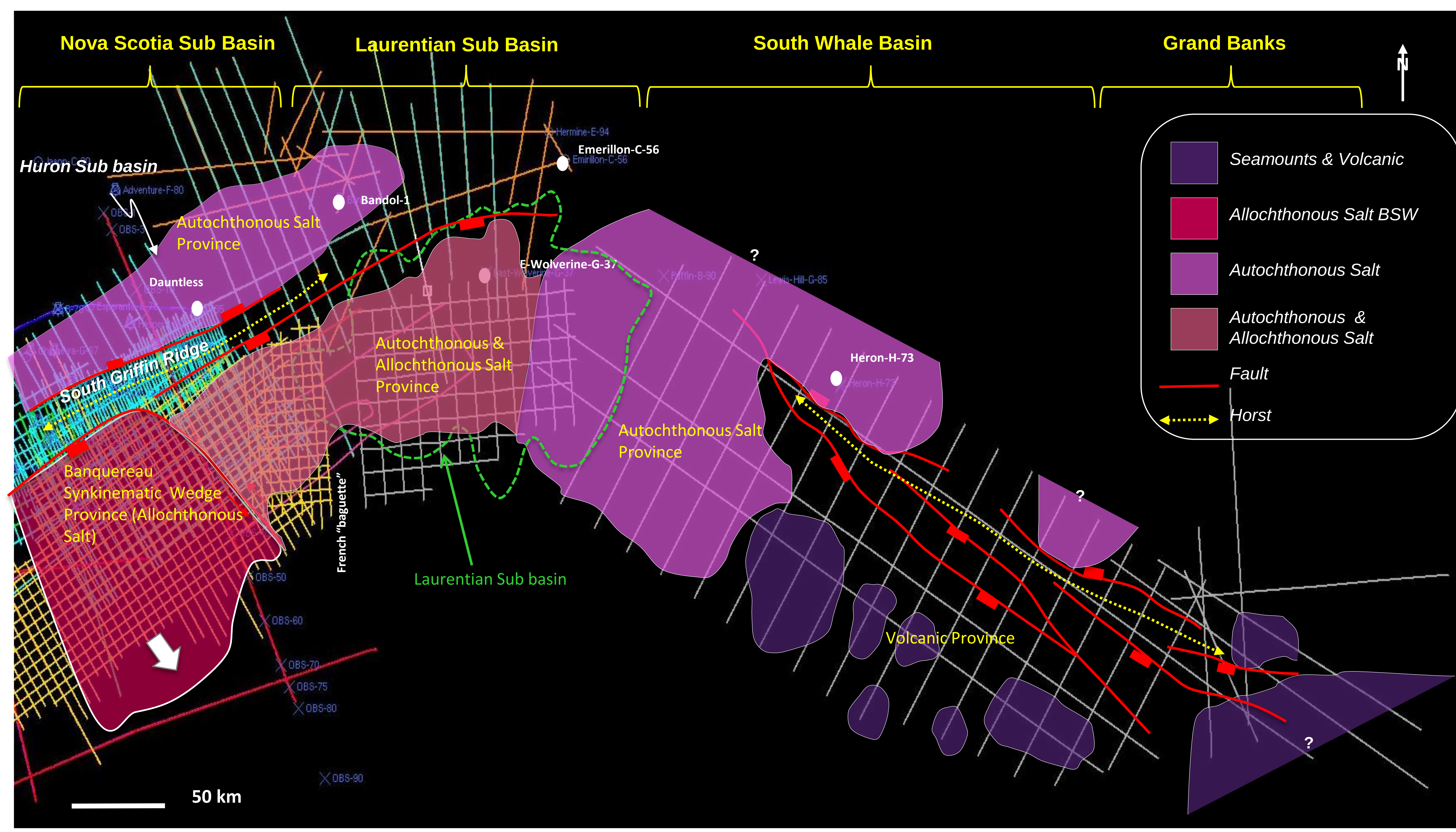
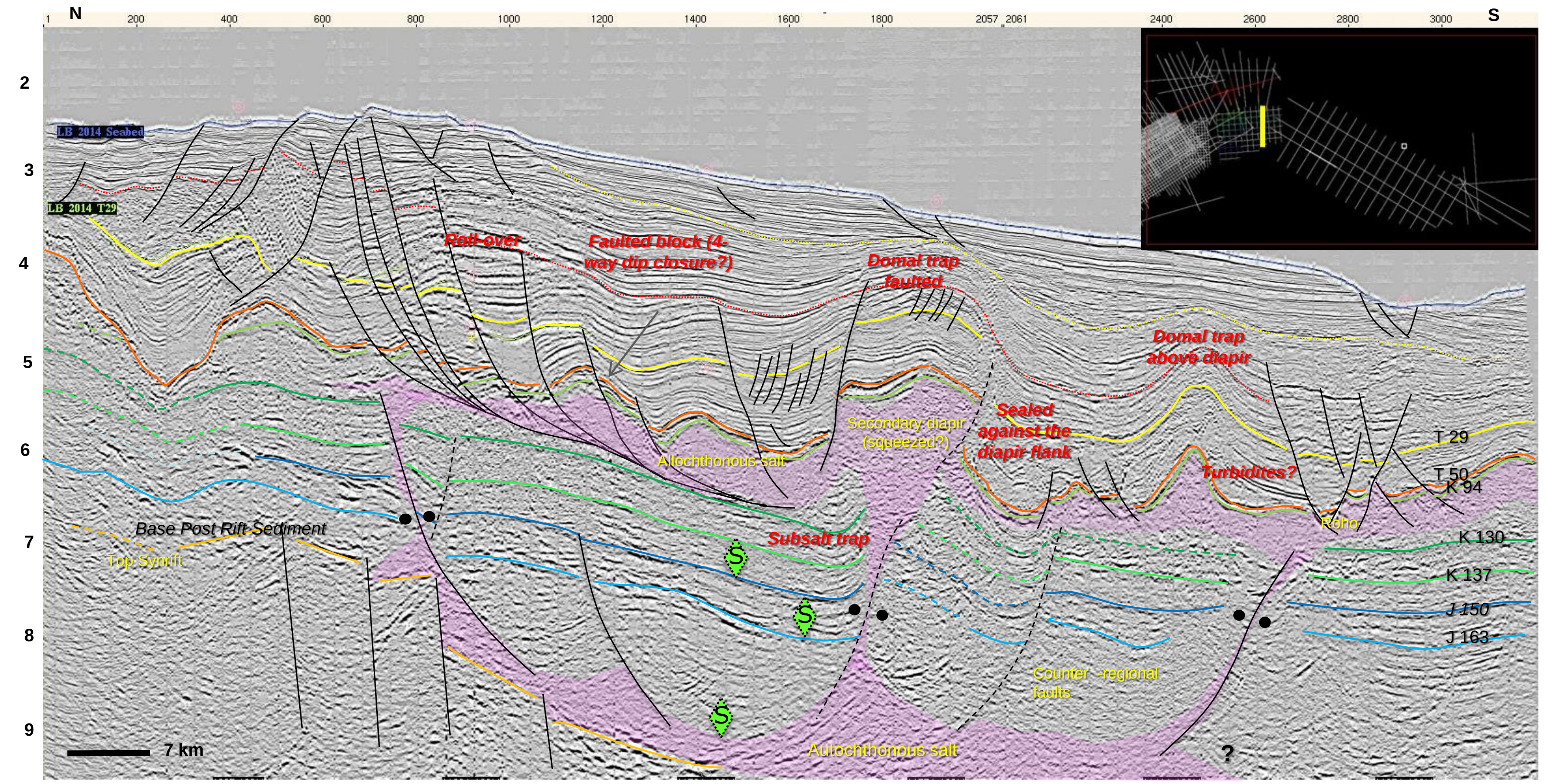


Figure 2 : map of the different geological provinces encountered in the studied area. The salt occurrence disappears eastward in the Western Grand Banks of Newfoundland. A volcanic province with some igneous plugs develops eastward



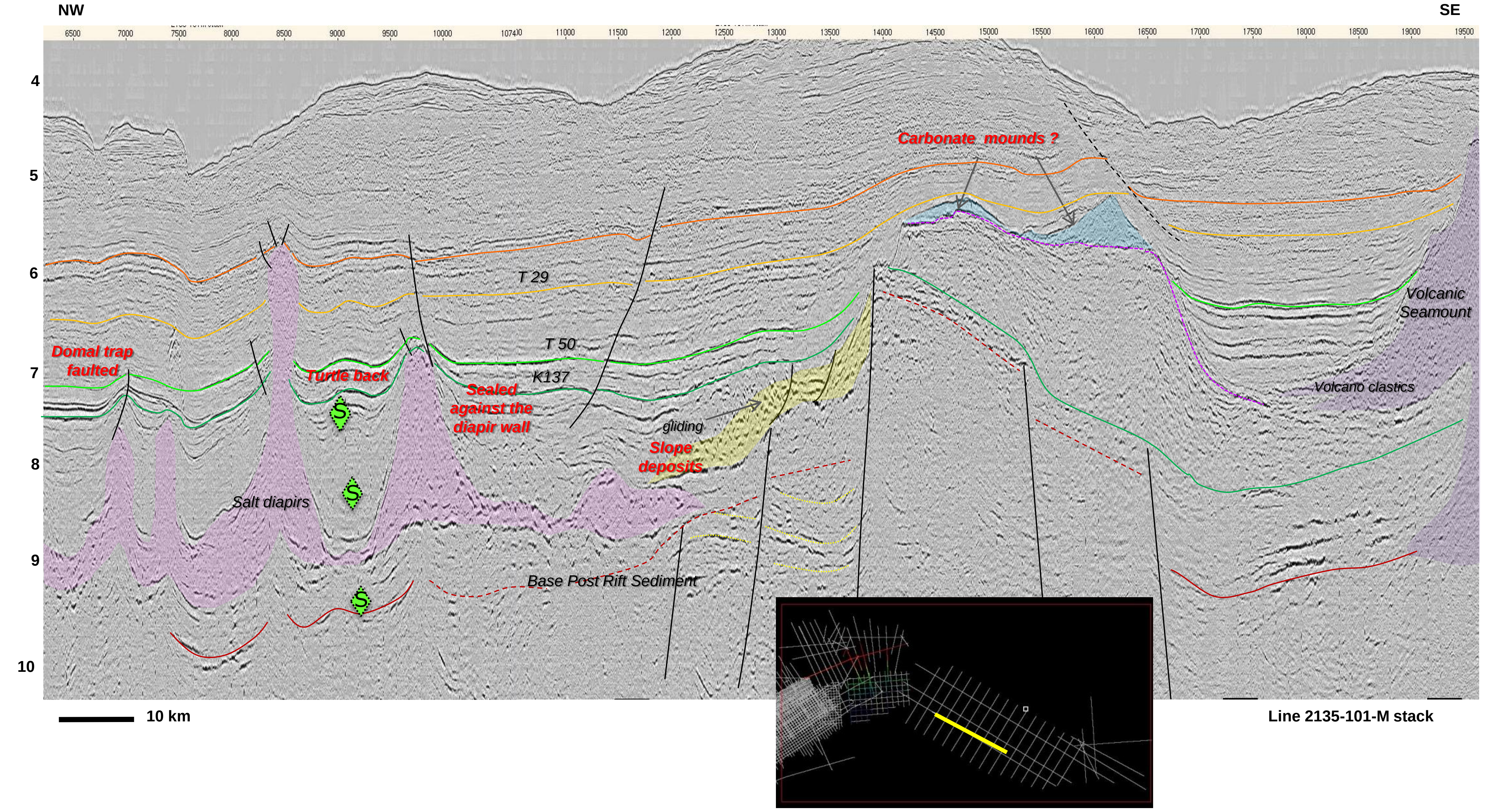
Line 1338-100M

Figure 1 : Seismic line in the Laurentian Sub-Basin showing the different salt-related trap styles

Two types of traps are highlighted in the studied area:

- those related to salt tectonics (Figure 1 and Figure 2). They occur in the Laurentian Sub-Basin and the South Whale Basin;
- those related to stratigraphic traps (Figure 1 – Pl 7.4.9). They are mainly located in the Volcanic Province.

The salt-related traps are located mostly above the allochthonous salt in the Laurentian Sub-Basin, whereas it is positioned above the autochthonous salt in the South Whale Basin in which no allochthonous salt is present (Figure 1 and Figure 2). Potential traps may develop above and around diapirs as hydrocarbon sealed against the diapir flank, as a domal trap faulted or domal trap above diapirs, turtle-back feature, and subsalt trap with reservoir beds pierced by diapirs and upturned to form a series of small stacked traps. Roll-over anticlines associated to listric faults close to the slope of the basin and faulted block (four-way dip closure) may also be of interest.



Line 2135-101-M stack

Figure 2 : Seismic line in the South Whale Basin displaying a basement high between the Autochthonous Salt Province and the Volcanic Province. Most of the traps are associated with salt tectonics, few ones with carbonate mounds

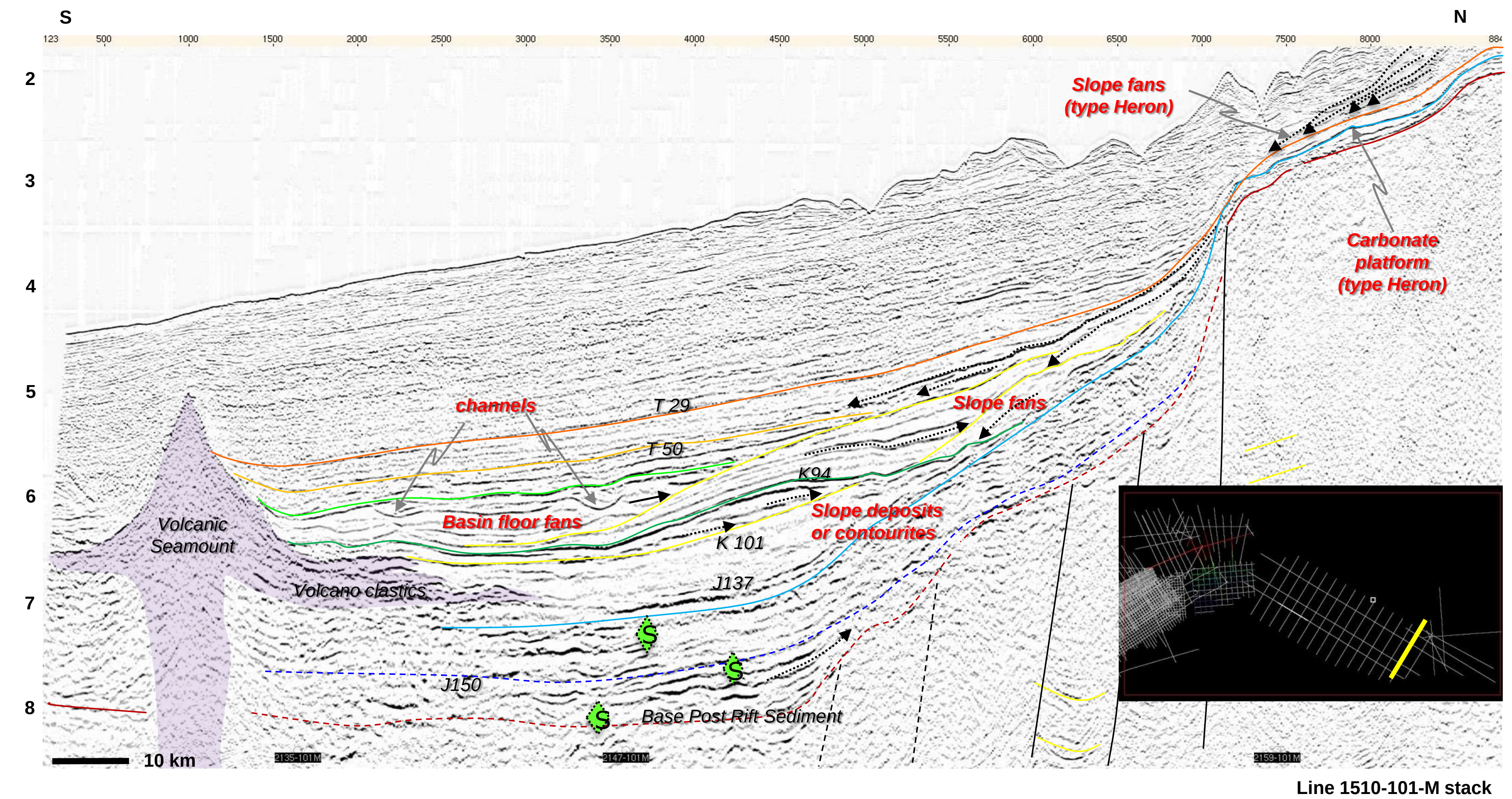


Figure 3 : Seismic line through the Volcanic Province presenting stratigraphic traps on the shelf and in the basin.

Stratigraphic traps may occur in the Laurentian Sub-Basin but are better highlighted in the Volcanic Province. Indeed, this part of the margin shows complex depositional patterns as turbidites, slope fans, basin floor fan, channels and possibly some contourites. Slope fans have been defined within the basin and above the carbonate platform on the shelf (Figure 3). Carbonate mounds are expected above basement high (Figure 2 – Pl 7.4.8) between the Autochtonous Salt Province and the Volcanic Province.
The Avalon Unconformity (associated to the horizon K137) is well extended on the shelf and on the slope where dipping Jurassic sediments were truncated and later buried by Early Cretaceous sediments (East-Wolverine-G-37), and provides a potential stratigraphic trap. The T29 and T50 horizons correspond also to unconformities which eroded Cenozoic and Late Cretaceous sandstones and shales, but they are mainly developed on the shelf edge where sediment layers are thin due to bypass or erosion above the Base Post Rift Sediment (Figure 3), and do not induce any prominent stratigraphic trap.

The most promising play in the BSW province consists of large rollover structures and associated normal fault blocks in the uppermost part of the slope where sand of Late Jurassic and Cretaceous age are expected. In the Banquereau Wedge itself (Figure 4), numerous structural traps can be recognized including roller and raft structures, local contractional anticlines (in the upper part and in the “toe zone”), turtle back. Isolated diapirs issued from the allochtonous salt and piercing the Mesozoic and early Tertiary cover have generated classic salt related structures (dome anticline, diapir flank traps).

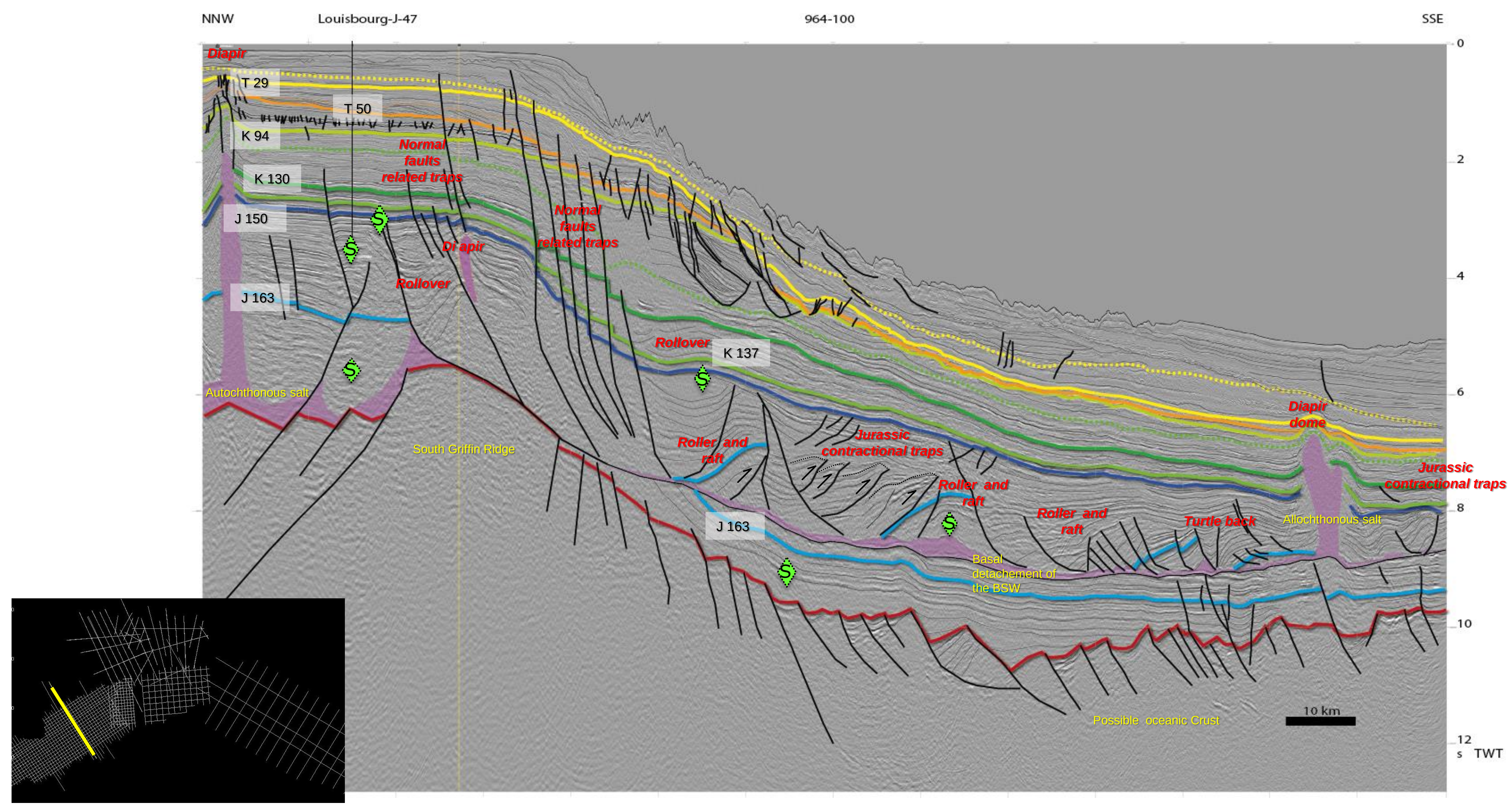
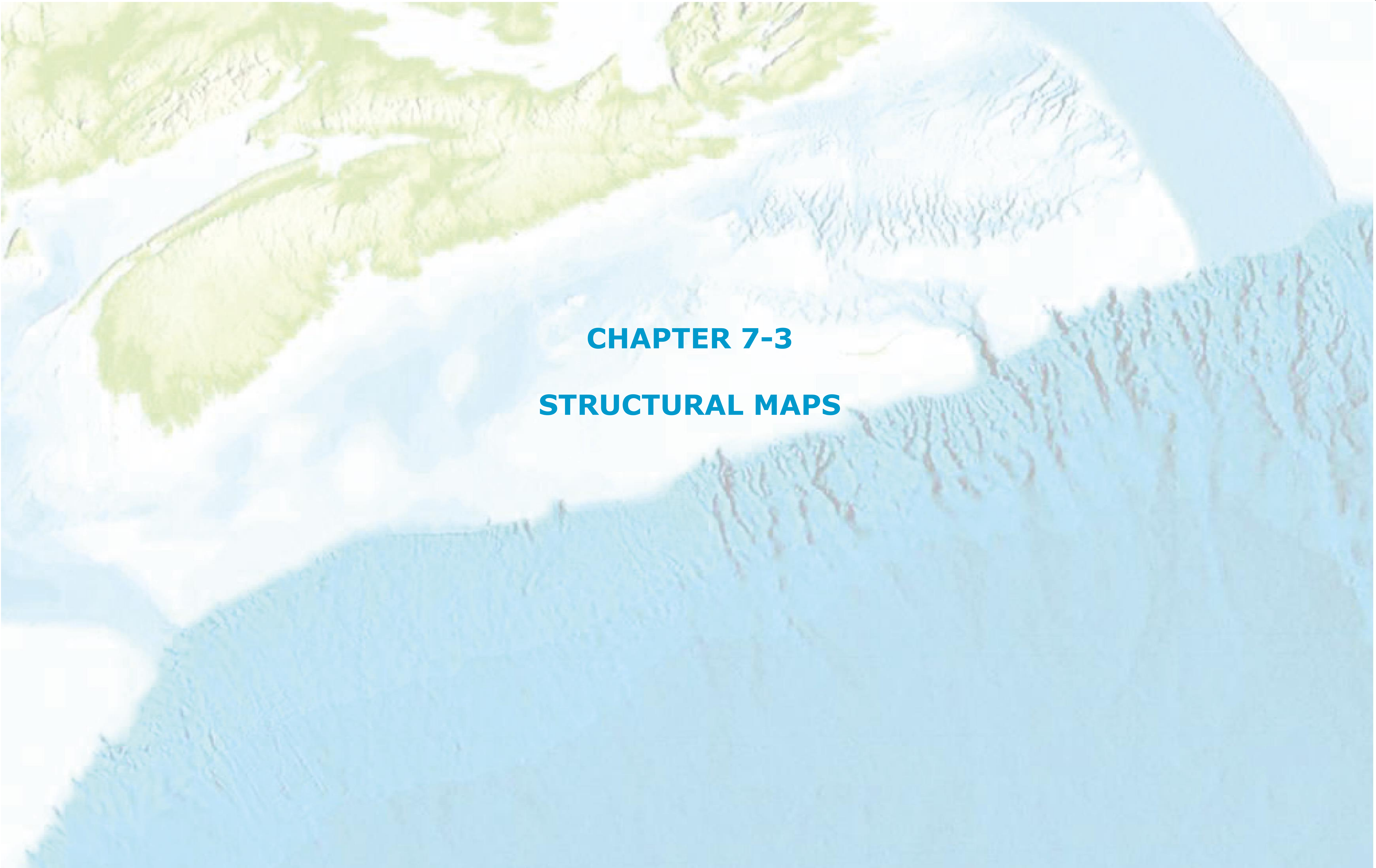


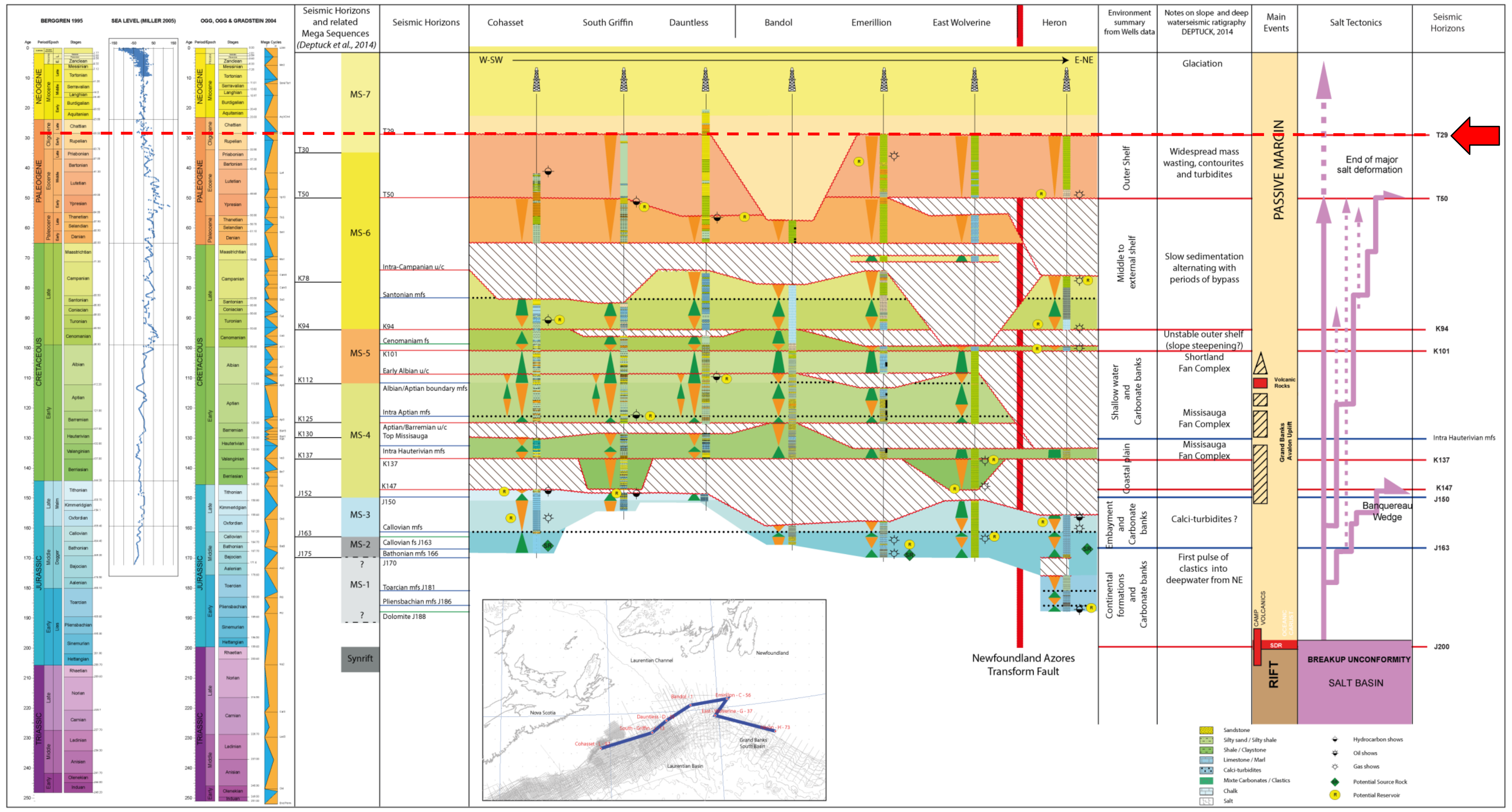
Figure 4 : Seismic 964-100 across the Banquereau Synkinematic Wedge (BSW) showing various structural plays.



CHAPTER 7-3

STRUCTURAL MAPS

Tectono-stratigraphical chart



Horizon definition

The horizon named "Mid-Oligocene unconformity" (or T29) is the amalgamation of successive erosional surfaces corresponding to glacial episodes occurring from Rupelian to Priabonian times which removed a large amount of sediments from Tertiary to Late Cretaceous in age (incision can affect Cenomanian units along the slope of the basin). The attributed age of this surface has been estimated at 29 million years.

Well-to-seismic tying

The well-to-seismic tying is done on the three reference wells and the additional well Emerillon-C-56. T29 does not have a typical acoustic signature but is reliably tied to the seismic through the seismic features (erosional truncations) and the correlation with the Nova Scotia Play Fairway Analysis 2011. The well-to-seismic calibration of Bandol-1 took also largely in consideration the result of the calibration of the well Dauntless-D-35 located at the West of the Laurentian Basin. The results of the well-to-seismic tie present a good correlation..

Seismic picking and uncertainty

The shallow horizons as T29 lack of biostratigraphic results in some wells (Emerillon-C-56). The seismic correlation of such a timeline over the Laurentian Sub Basin until the Western Grand Banks of Newfoundland is uncertain and speculative. Nevertheless, the truncations are clear on the seismic and consistent at the basin scale. T29 erosional surface is characteristic of the Oligocene glacial event and is buried by the Oligocene Neogene last phase of basin infilling. It is particularly true on the slopes of the Laurentian Sub Basin, the South Whale Basin and the Western Grand Banks of Newfoundland. Eastwards on the margin, the horizon T29 tends to be eroded (South Whale Basin and Western Grand Banks), and its correlation from Heron-H-73 (shelf area) down to the basin is in a certain manner speculative.

Structural description

T29 horizon dips uniformly South in the Laurentian Sub Basin and Southwest in the South Whale Basin and the Western Grand Banks of Newfoundland. No major structural fault has been observed.

On the slope of the Laurentian Basin, few erosions resulting from canyon incisions or gliding area are located close to East-Wolverine-G-37. Nevertheless, with only 2D seismic lines, it is not possible to estimate the extension of these areas properly. Eastwards, all along the South Whale Basin margin, a narrow slope failure affects T29 horizons.

In the basin, several salt diapirs pierce T29 in the Laurentian Sub Basin and the South Whale Basin, but they fold less T29 than the deeper horizons. Eastwards, no more salt dome affects T29 but Early Cretaceous volcanic seamounts (Fogo type) prevent the deposition of T29 locally.

In the deep offshore where salt dome and seamount are absent, maximum depths are located in the Southeast of the Laurentian Sub Basin.

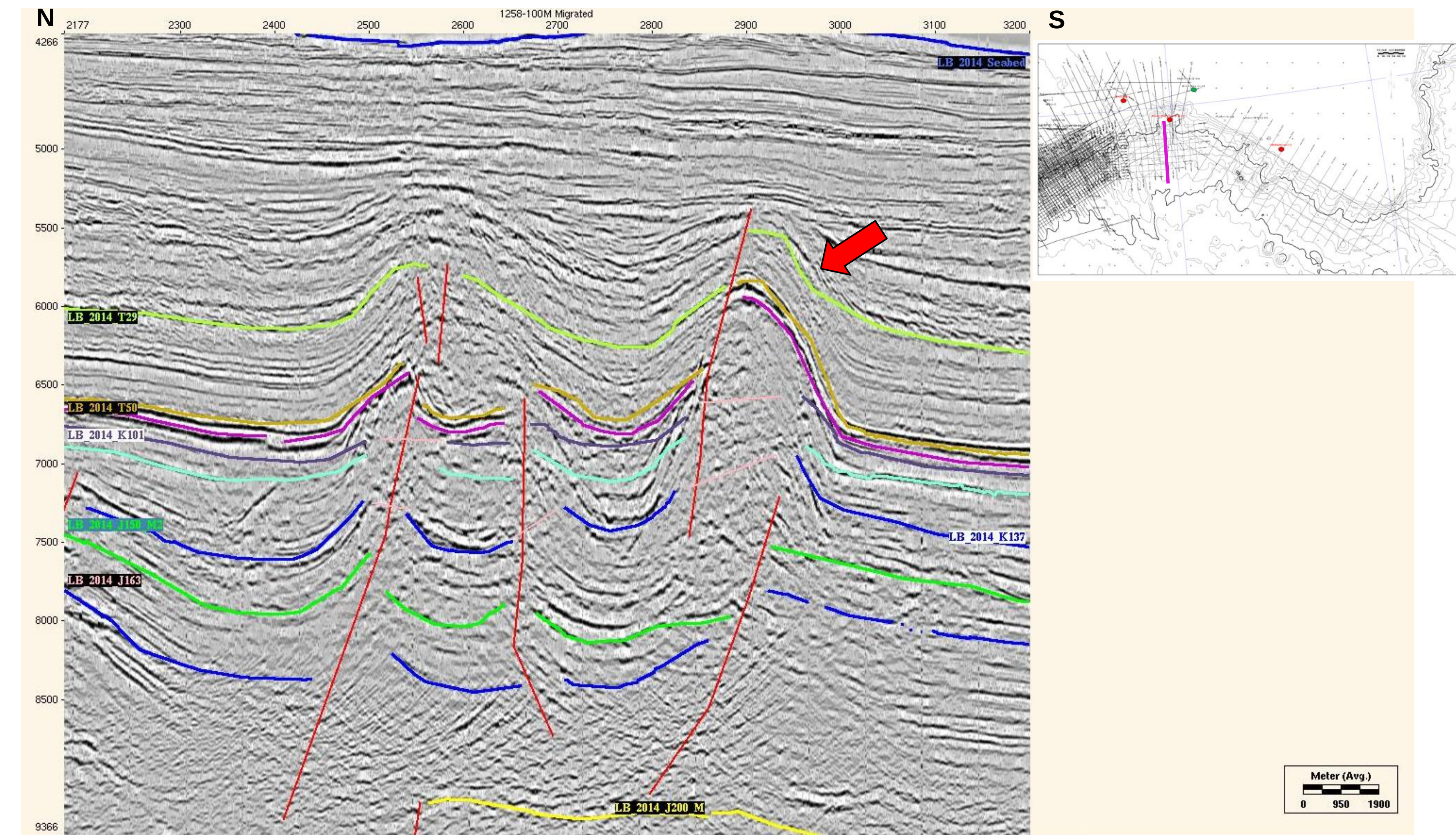


Figure 1 : Seismic line in the Laurentian Sub-Basin showing salt domes beneath T29

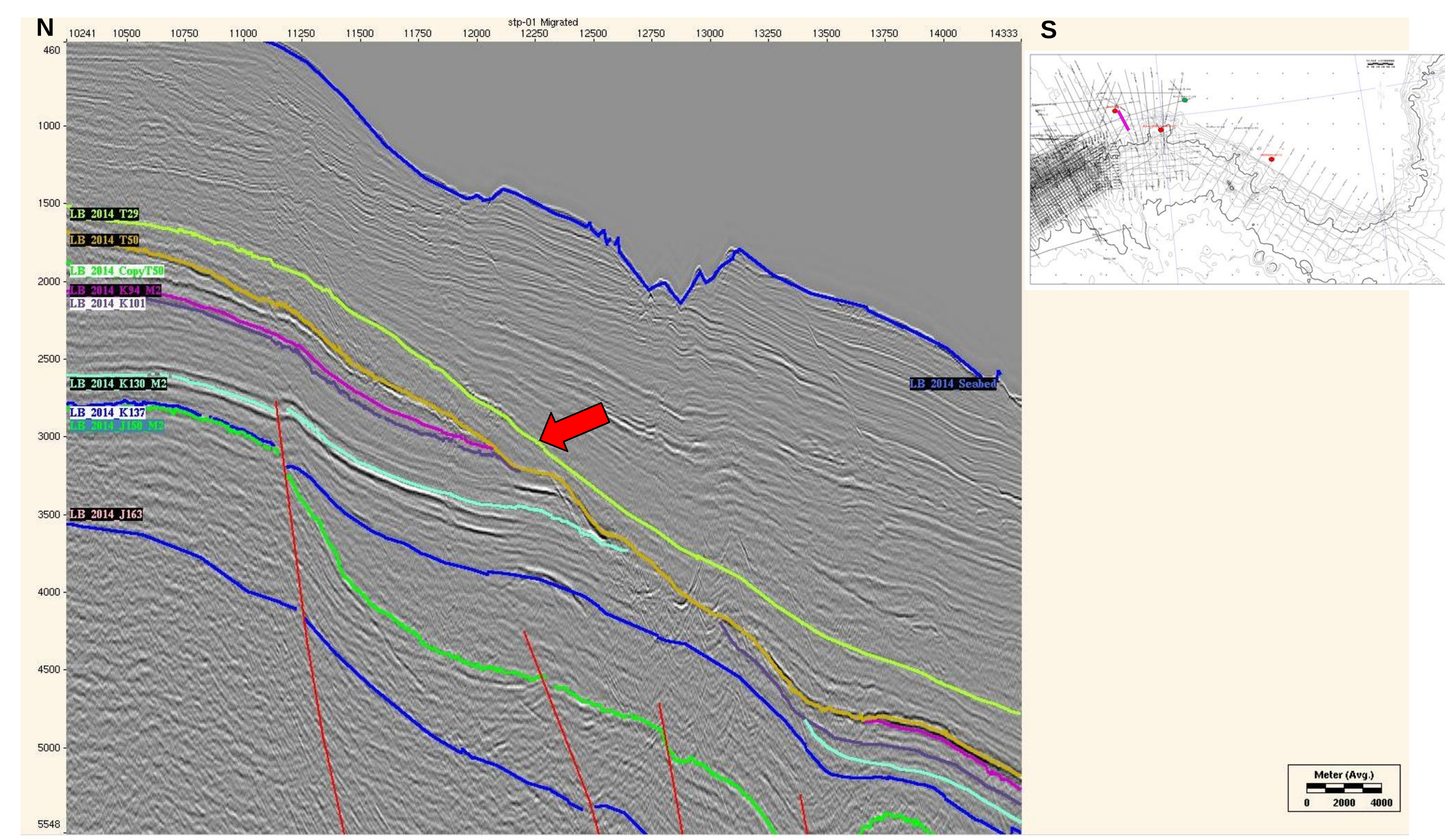
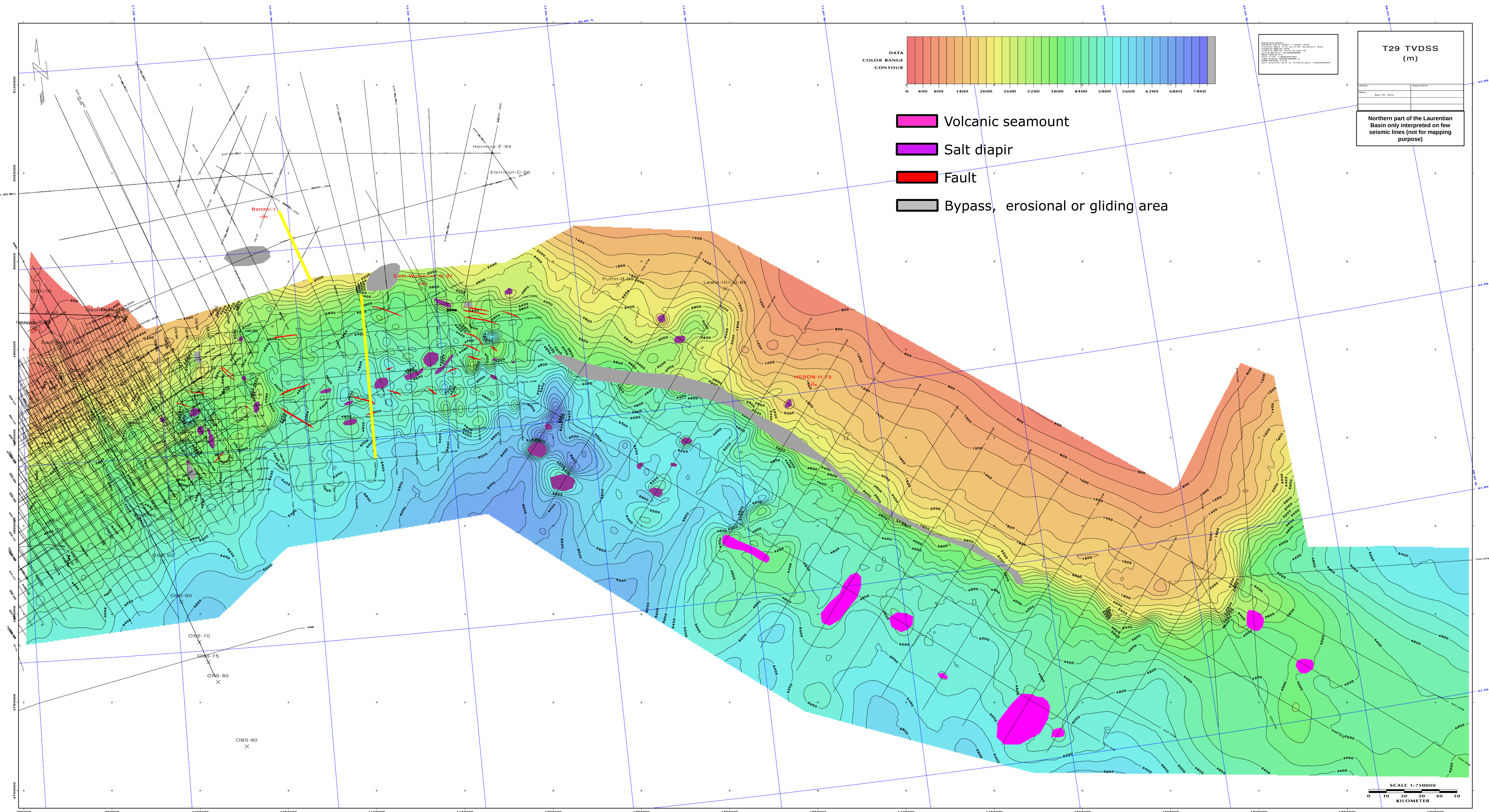


Figure 2 : Seismic line in the slope of the Laurentian Sub Basin showing truncation below T29

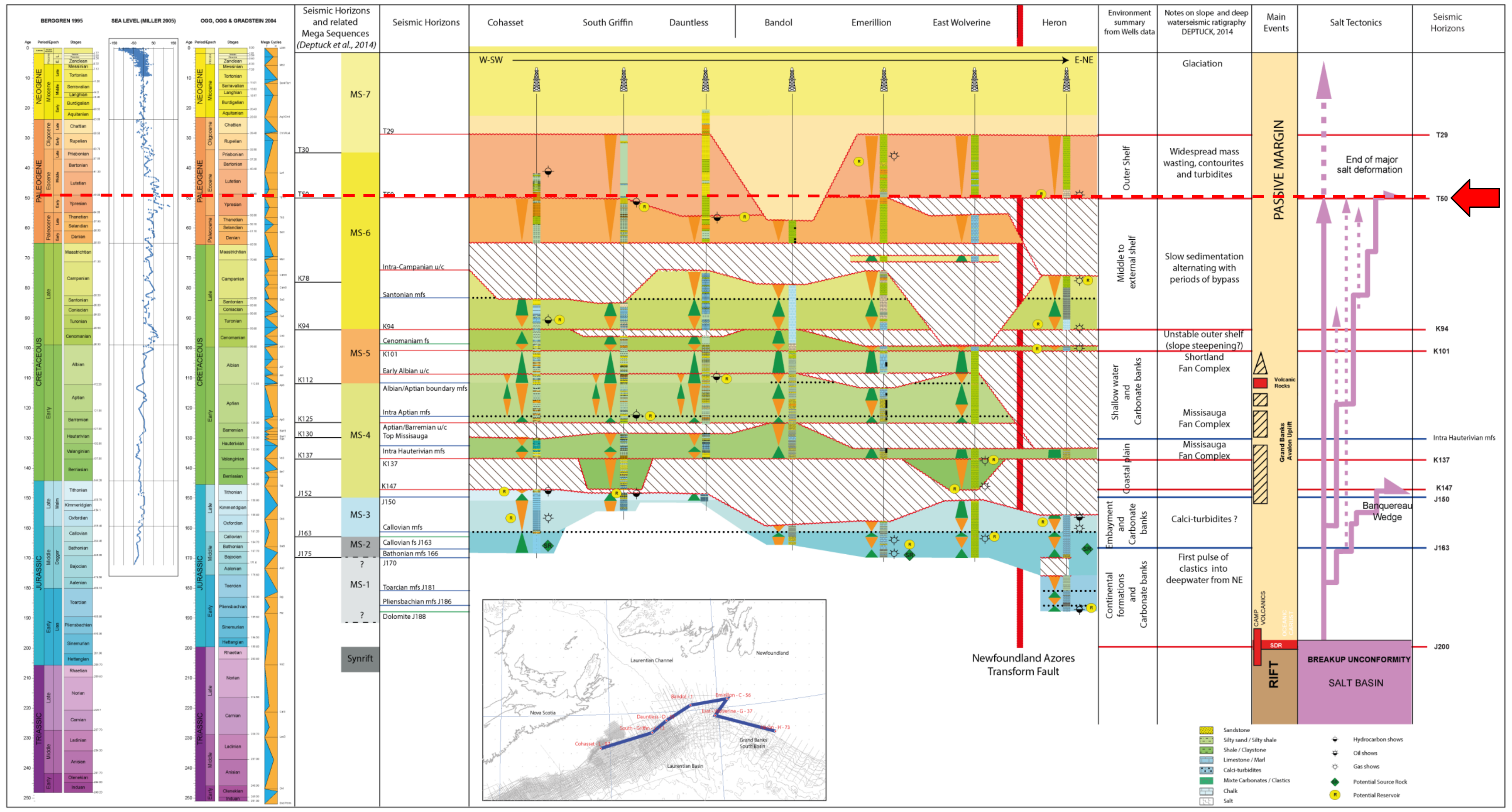
SEISMIC INTERPRETATION – STRUCTURAL MAPS



T29 (Mid-Oligocene Unconformity) Depth Structural Map

PLATE 7.3.3

Tectono-stratigraphical chart



Horizon definition

The horizon named “Base of the Ypresian chalks” (or T50) is the last episode of the prolific chalk deposition through Late Cretaceous and Tertiary time. It is confined to Ypresian in age and represents a maximum flooding surface recognized over most of the Scotian Shelf until the Western Grand Banks of Newfoundland.

Well-to-seismic tying

The well-to-seismic tie of the T50 horizon is done on two of the three reference wells (absent in Bandol-1) and on the additional Emerillon-C-56 well. The acoustic log signature of the Ypresian chalks is a sharp base with a gradational top evolving from chalk to shale facies (Heron-H-73). The formation is usually too thin to distinguish seismically the top from the base. As a result, the best choice for tying the unit is its base and corresponds to a strong amplitude trough on the seismic. The results present a very good correlation, highlighted by the associated strong and continuous erosion all along the slope (as on East-Wolverine-G-37).

Seismic picking and uncertainty

The horizon T50 picking is constrained on the shelf by the well-to-seismic tying. The associated seismic reflection is continuous with a thick series separating the Ypresian chalks from the Wyandot chalks. On the slope (East-Wolverine-G-37) and within the basin, the series becomes thin due to erosion, and the picking is driven by the seismic facies, and is less accurate. There, T50 is defined as the top of a continuous and strong energy package containing the chalk deposits of the Late Cretaceous and Cenozoic, and is usually overlain by a transparent seismic facies related to Eocene shales. Fifty milliseconds below T50, it is frequent to observe in the Laurentian Sub Basin two to three seismic reflectors corresponding to K94 and K101 horizons, sometimes eroded by the T50 horizon. When affected by salt tectonics (diapirs and associated faulting), the T50 interpretation is more uncertain.

Structural description

T50 horizon is dipping uniformly South in the Laurentian Sub Basin, and Southwest in the South Whale Basin and the Western Grand Banks of Newfoundland. It is affected in the Laurentian Sub Basin and the South Whale Basin by East / West and Northwest / Southeast normal faults dipping South. They are associated to gliding on the slope and to salt tectonics in the basin (listric faults, roll-over anticline and faulted salt dome). T50 is eroded by several Oligocene to Miocene incisions on the shelf (especially in the Laurentian Sub Basin) and on the slope.

The deposition of T50 happens during the final stage of salt tectonics. Hence, it is generally pierced and is lying close to the top of the latest salt diapirs. The shelf is not affected by the salt tectonics except partly in the South Whale Basin.

The continental shelf domain of T50 goes steeply into the slope domain, affected locally by underlying salt diapirs in the South Whale Basin. It erodes on the slope the deeper horizon K94, K101 and sometimes K130 (close to East-Wolverine-G-37).

Eastwards, no more salt dome affects T50 but Early Cretaceous volcanic seamounts (Fogo type) prevent the deposition of T50 locally. T50’s maximum depths are reached on the deep offshore of the South Whale Basin.

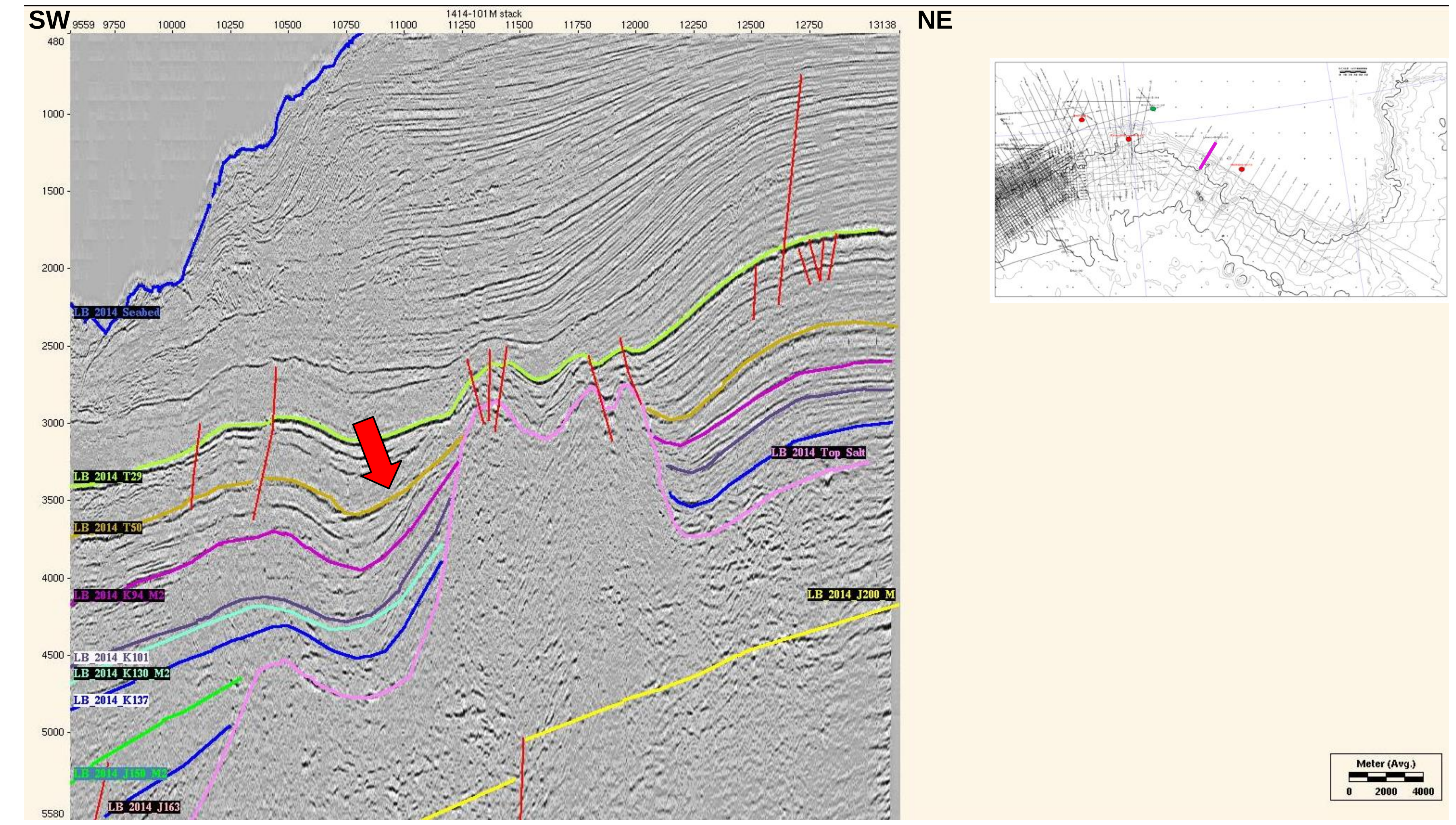


Figure 1 : Seismic line in the Western Grand Banks showing a volcanic seamount close to T50

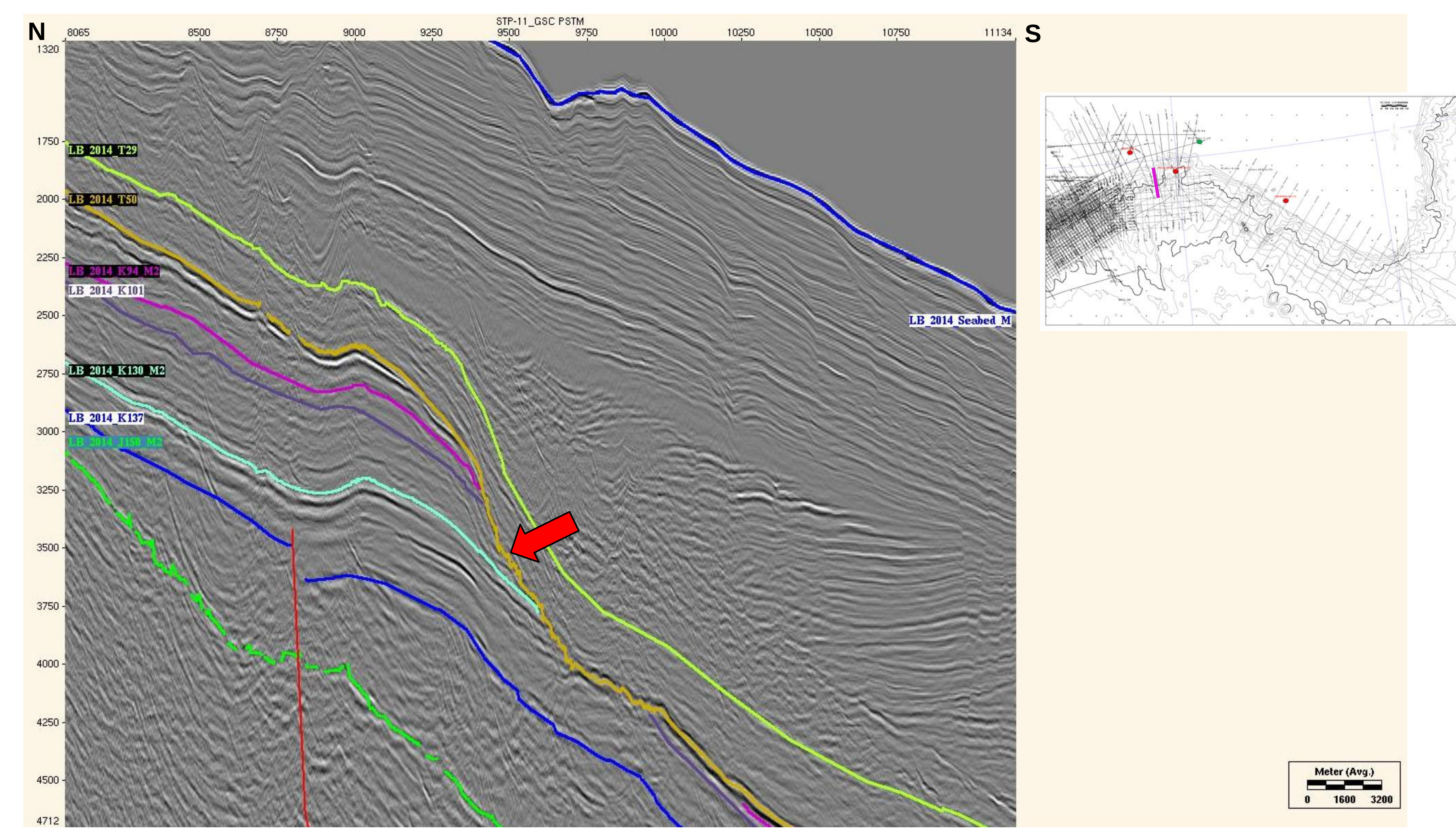
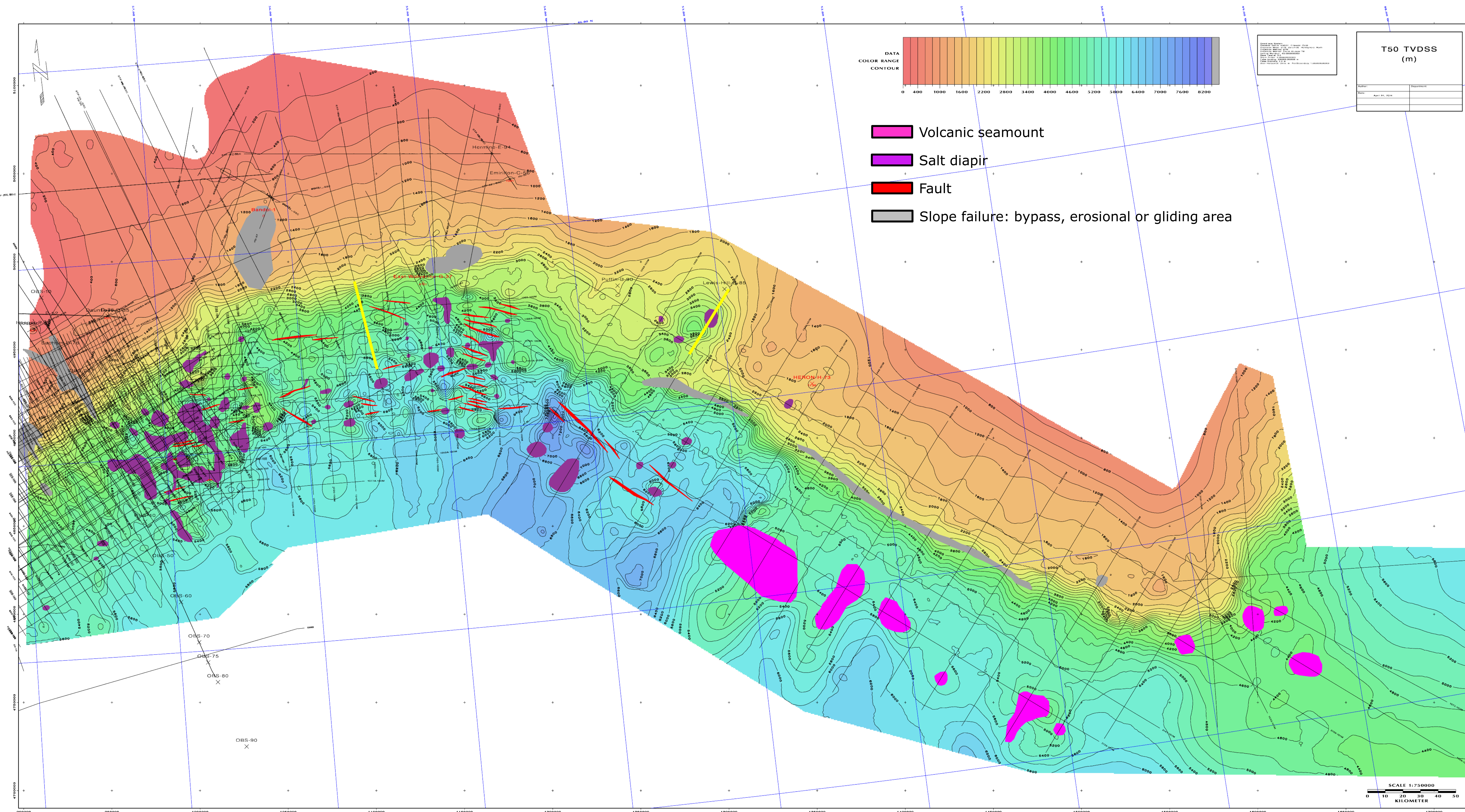


Figure 2 : Seismic line in the slope of the Laurentian Sub Basin showing truncation below T50

SEISMIC INTERPRETATION – STRUCTURAL MAPS

Laurentian sub-basin study - CANADA – June 2014

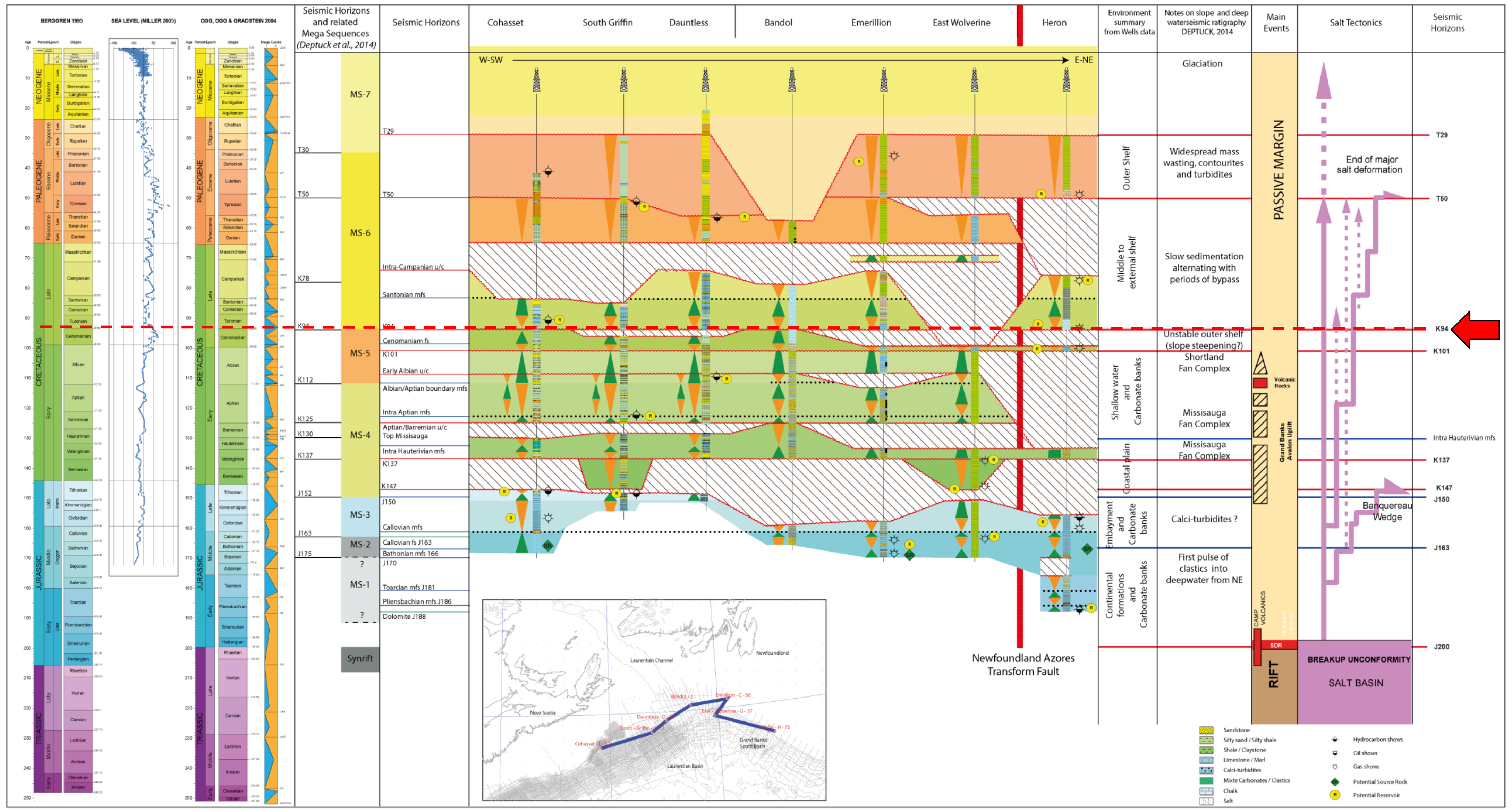


T50 (Base Ypresian Chalk) Depth Structural Map

PLATE 7.3.5

SEISMIC INTERPRETATION – STRUCTURAL MAPS

Tectono-stratigraphical chart



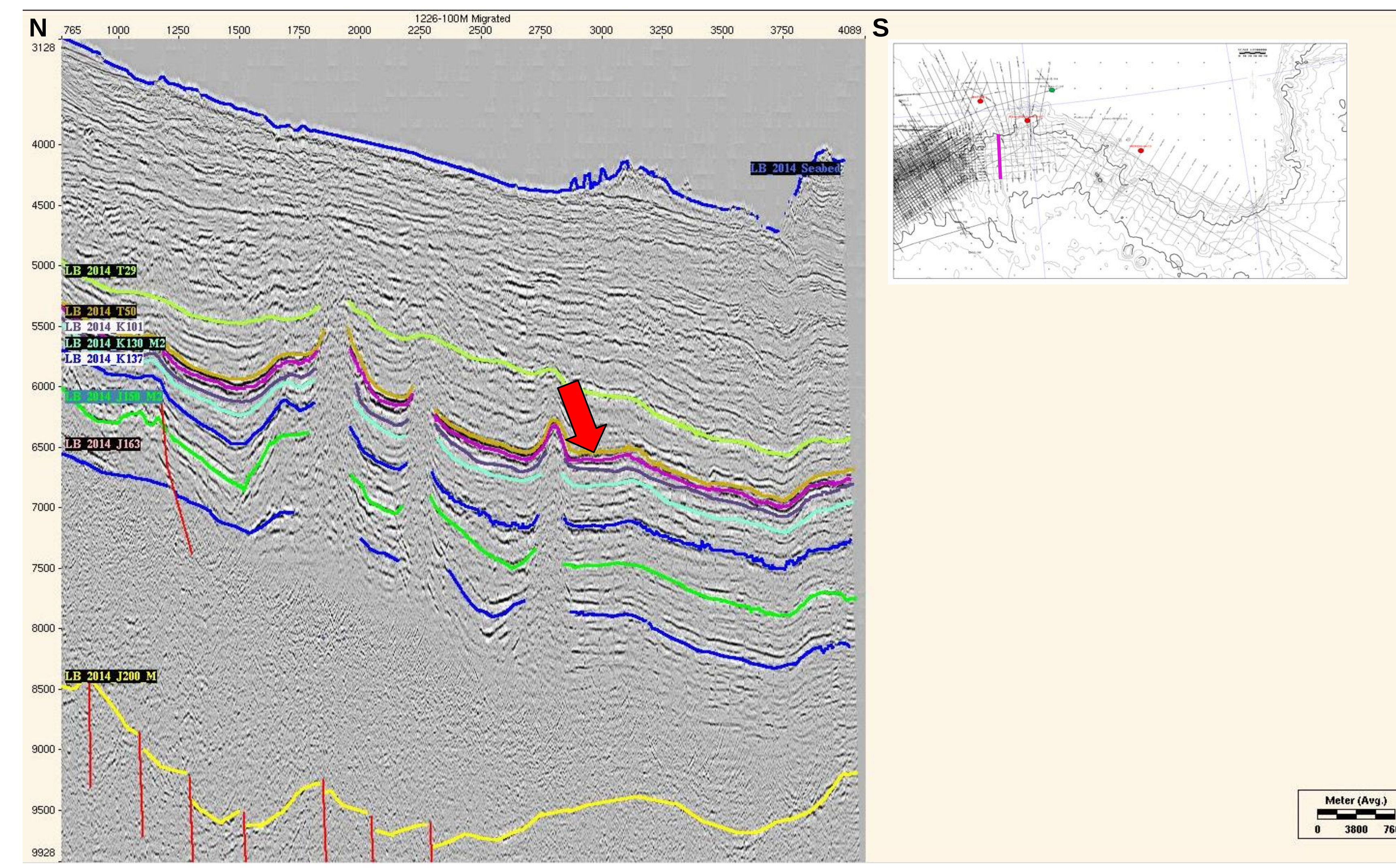


Figure 1 : Seismic line in the Laurentian Sub-Basin showing salt domes piercing K94

Horizon definition

The horizon named "Turonian Cenomanian unconformity" (or K94) mainly corresponds to a submarine erosional surface equivalent to the base of the Petrel Member on the shelf. The Petrel Member is a regional seismic marker corresponding to a chalk unit deposited within the transgression shale sequenece of the Dawson Canyon Formation. It is the onset of the chalk production through the Late Cretaceous and is recognized over most of the Scotian Shelf until the Western Grand Banks. Basinwards, the Petrel Member is thinning and evolves in a more shaly facies.

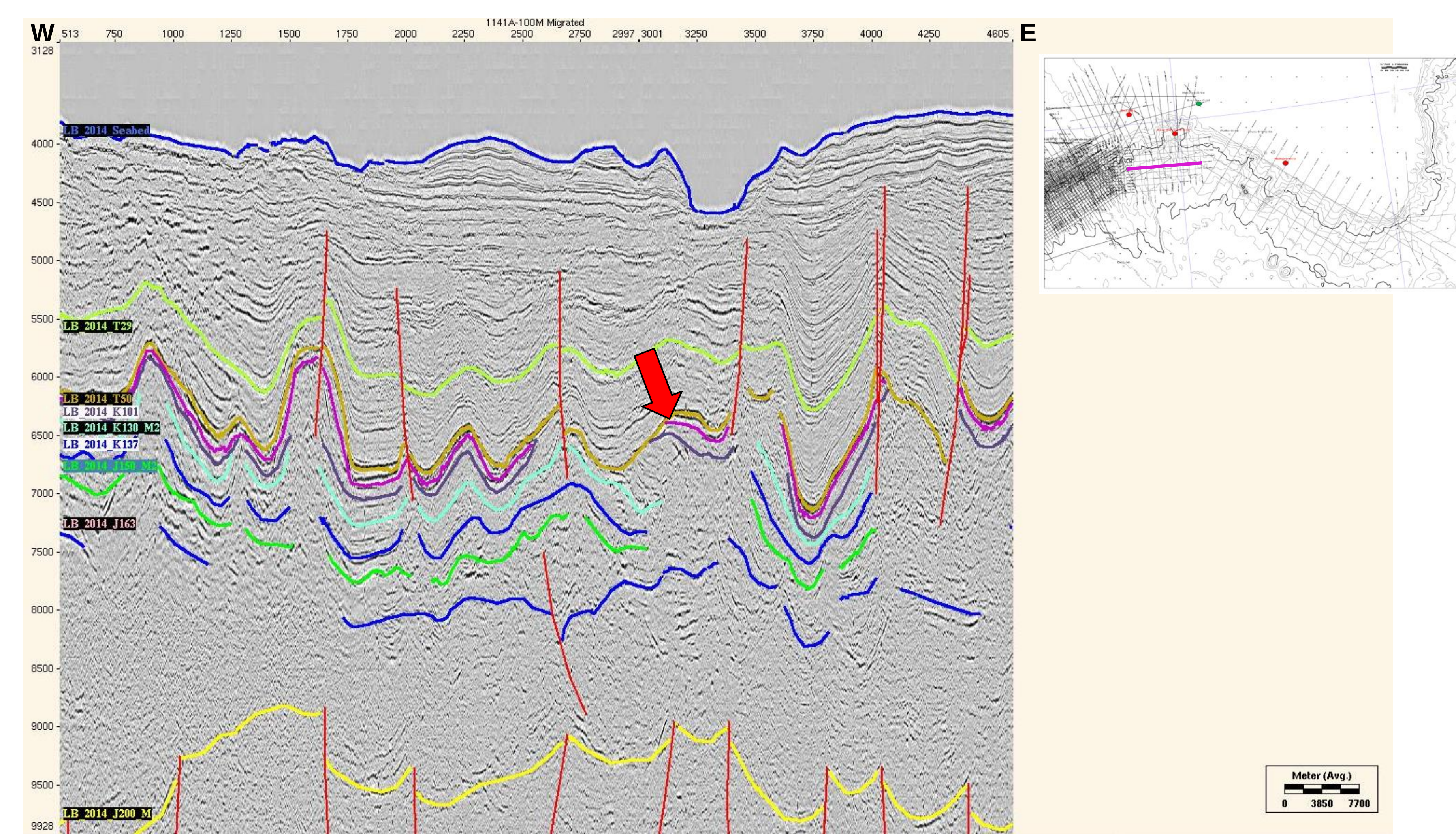


Figure 2 : Seismic line in the slope of the Laurentian Sub Basin showing K94 truncated by T50

Well-to-seismic tying

The well-to-seismic tying of the K94 horizon is done on the three reference wells and the additional well. The signature of K94 is a sharp decrease of the sonic log and corresponds to a strong amplitude trough on the seismic. The Petrel Member is usually too thin (sediment input quite low during the Cretaceous within the Laurentian Sub Basin, and locally eroded by the horizons T29 and / or T50 mostly on the slope of the basin) to allow distinguish seismically the top from the base. The results present a good correlation especially on the well Heron-H-73.

Seismic picking and uncertainty

The K94 horizon corresponds to the top of the limestone Petrel Member, thickness of which is large on the shelf where it corresponds to a continuous reflector well-calibrated on the wells. Basinwards, where the Petrel Member is thinning and starts to be more shaly or affected by salt tectonics or even eroded, the picking is more uncertain, especially eastward where bypass or erosional gliding disconnect the K94 located on the shelf (and calibrated to Heron-H-73) from the one located in the basin.

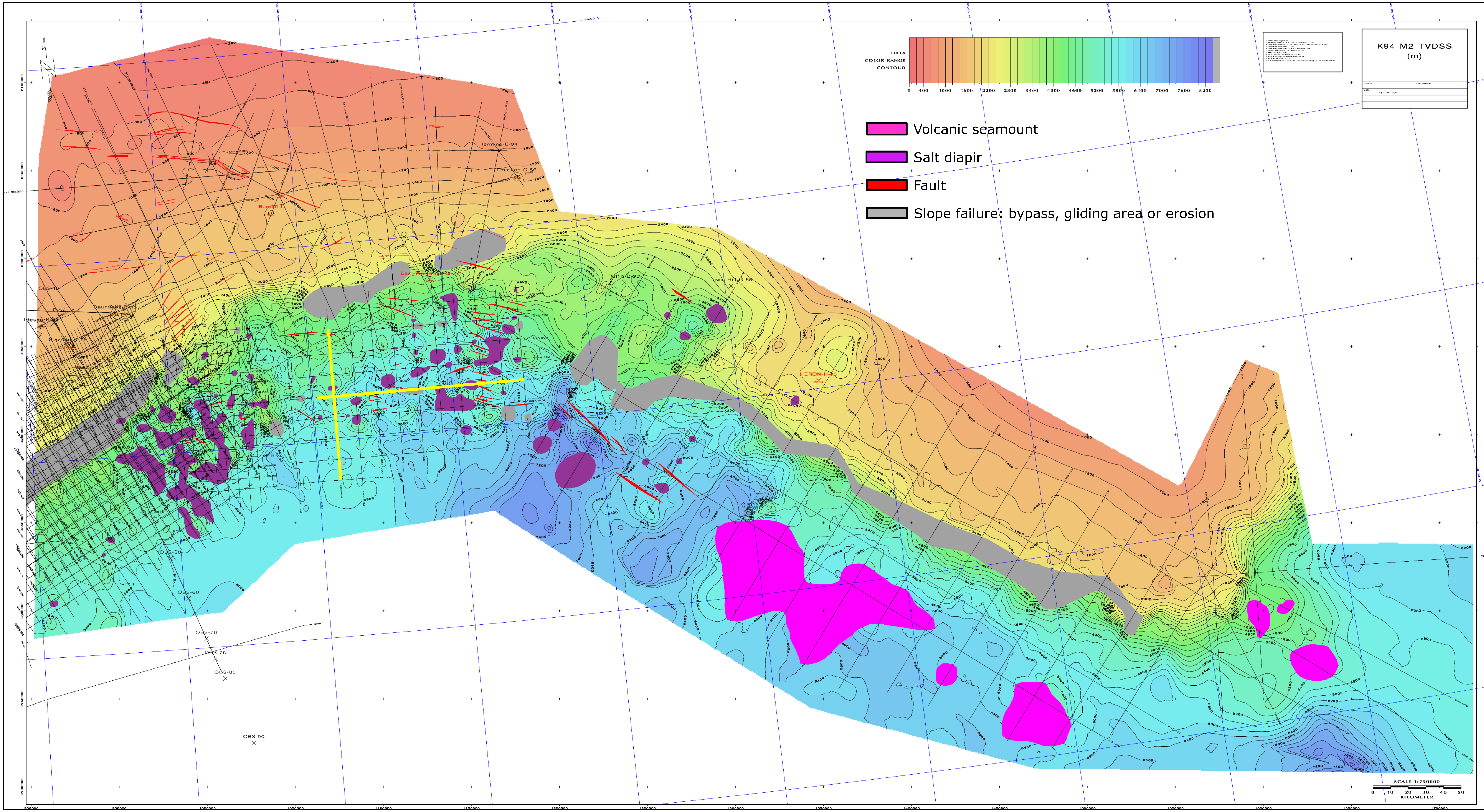
Structural description

In the shelf area, K94 horizon dips more gently in the South Whale Basin than in the Laurentian Sub Basin and the Western Grand Banks area. It is affected on the slope of the western Laurentian Sub Basin by East / West deltaic faults dipping South, and by Northwest / Southeast salt-related faults (listric faults, roll-over anticline and faulted salt dome) in the center of the Laurentian Sub Basin and of the South Whale Basin.

On the shelf, K94 horizon is preserved from salt tectonics, except in the South Whale Basin, where four diapirs are encountered. In the basin, numerous diapirs pierce K94 in the Laurentian Sub Basin and the South Whale Basin. K94 is usually lying at the average depth of the allochthonous salt bodies in the Laurentian Sub-Basin. Eastwards, no more salt dome affects K94 but Early Cretaceous volcanic seamounts (Fogo type) prevent the deposition of K94 locally.

All along the slope of the South Whale Basin and the Western Grand Banks, K94 horizon has been removed by the regional gliding as a narrow strip. K94 is also locally eroded by T50 on the slope of the Laurentian Sub Basin around the well East-Wolverine-G-37.

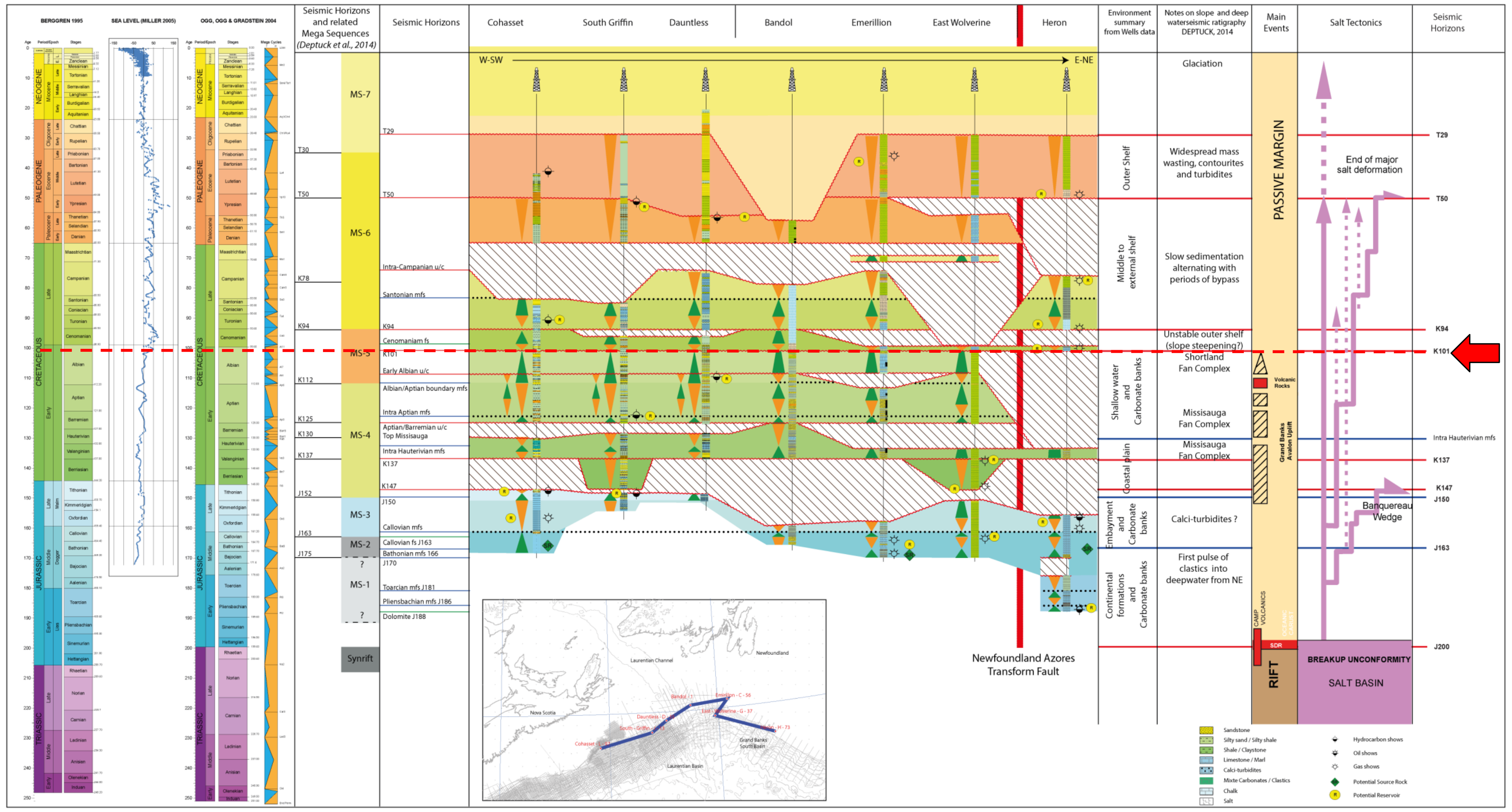
Maximum depths in the basin of K94 horizon are located in the distal part of South Whale Basin.



K94 (Turonian Cenomanian Unconformity) Depth Structural Map

PLATE 7.3.7

Tectono-stratigraphical chart



Horizon definition

The horizon named "Late Albian unconformity" (or K101) is defined as a sequence boundary within the Logan Canyon Formation separating the Cree Member from the overlying Sable Member.

Well-to-seismic tying

The well-to-seismic tie of the K101 horizon is possible on the three reference wells and on the additional well Emerillon-C-56. The K101 horizon does not have a regional acoustic signature (Bandol-1) and is too close from the K94 horizon to be well-distinguished (Heron-H-73 and East-Wolverine-G-37). Consequently, the biostratigraphic results (unconformities) cannot be perfectly tied to the seismic features. The well-to-seismic tie results present however a fair correlation, improved by the integration of the Nova Scotia Play Fairway Analysis 2011 and of the results of the Dauntless-D-35 calibration.

Seismic picking and uncertainty

On the shelf, the picking is based on the seismic facies and on the well-to-seismic calibration. Indeed, K101 corresponds to a strong energy package which is related to the transition between the shaly Sable Member and the fluvial sandstones of the Cree Member. On the slope, K101 is eroded by T50 or even by T29, and bypass is supposed in the South Whale Basin and the Western Grand Banks. In the basin, the surface is difficult to pick (poor seismic character and salt dome occurrences), and the interpretation has been driven by the seismic recognition. Its picking is there more uncertain.

Structural description

Northwards, K101 horizon is only interpreted on the South Whale Basin shelf on which it is dipping Southwest. It is eroded on the North of the Western Grand Banks. It is affected by East / West deltaic faults dipping South on the slope of the western Laurentian Sub Basin, and by Northwest / Southeast faults related to salt motion (listric faults, roll-over anticline and faulted salt dome) in a more distal part of the Laurentian Sub Basin and the South Whale Basin.

On the shelf, K101 horizon is preserved from salt tectonics except in the South Whale Basin. In the basin, numerous diapirs pierce K101 in the Laurentian Sub Basin and in the South Whale Basin. K101 is deposited during the motion of the allochthonous salt, and is seated close to the base of the salt diapirs (Laurentian Sub Basin). Eastwards, no more salt dome affects K101 but larger Early Cretaceous volcanic seamounts (Fogo type) prevent the deposition of K101 locally.

All along the slope of the South Whale Basin and the Western Grand Banks, K101 horizon has been removed by the regional gliding as a narrow strip. K101 is also eroded by T50 in some narrow areas on the slope of the Laurentian Sub Basin close to the well East-Wolverine-G-37. Maximum depths of K101 horizon are interpreted to be located on the Southeast of the Laurentian Sub Basin.

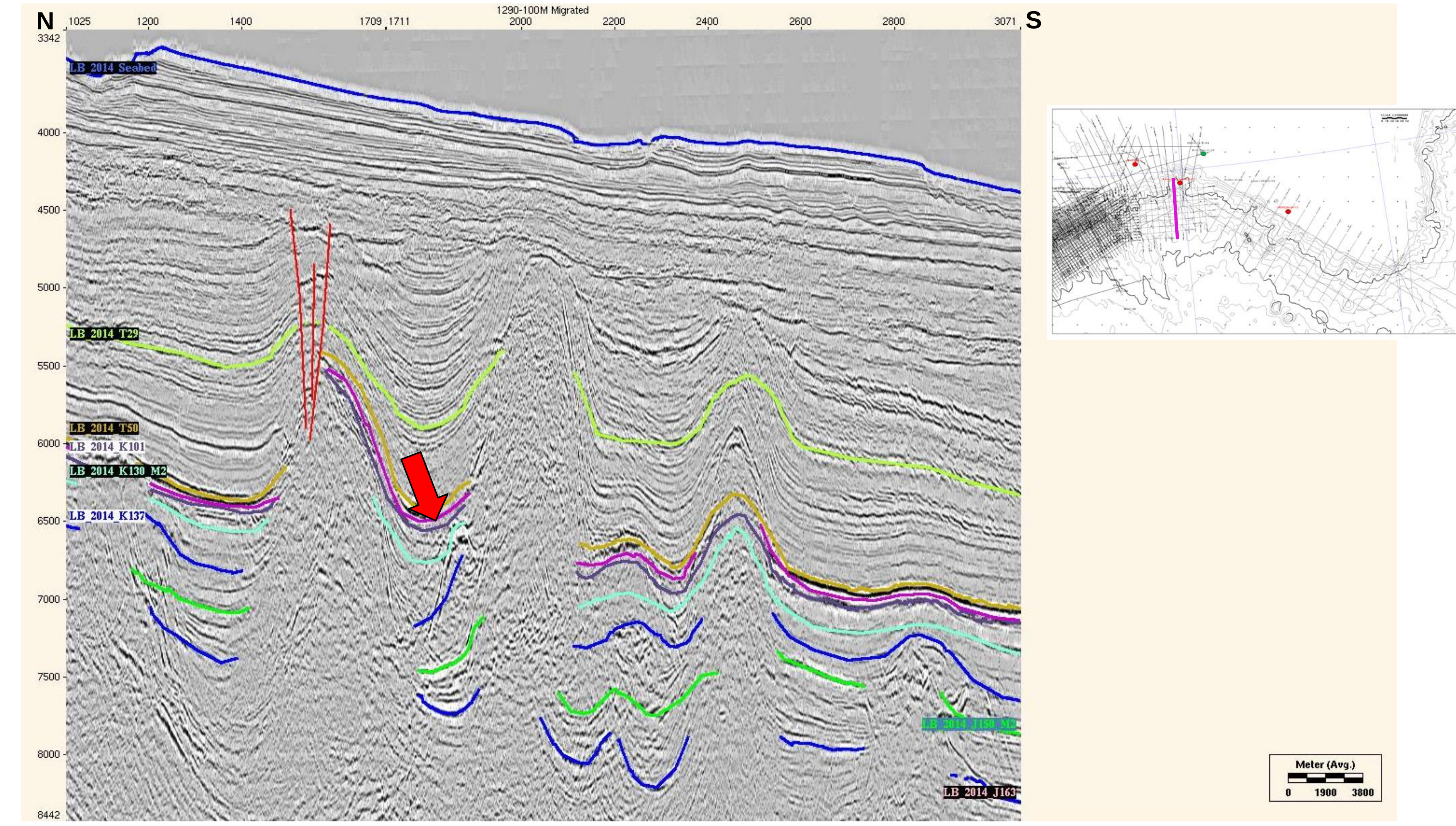


Figure 1 : Seismic line in the Laurentian Sub-Basin showing salt domes piercing K101

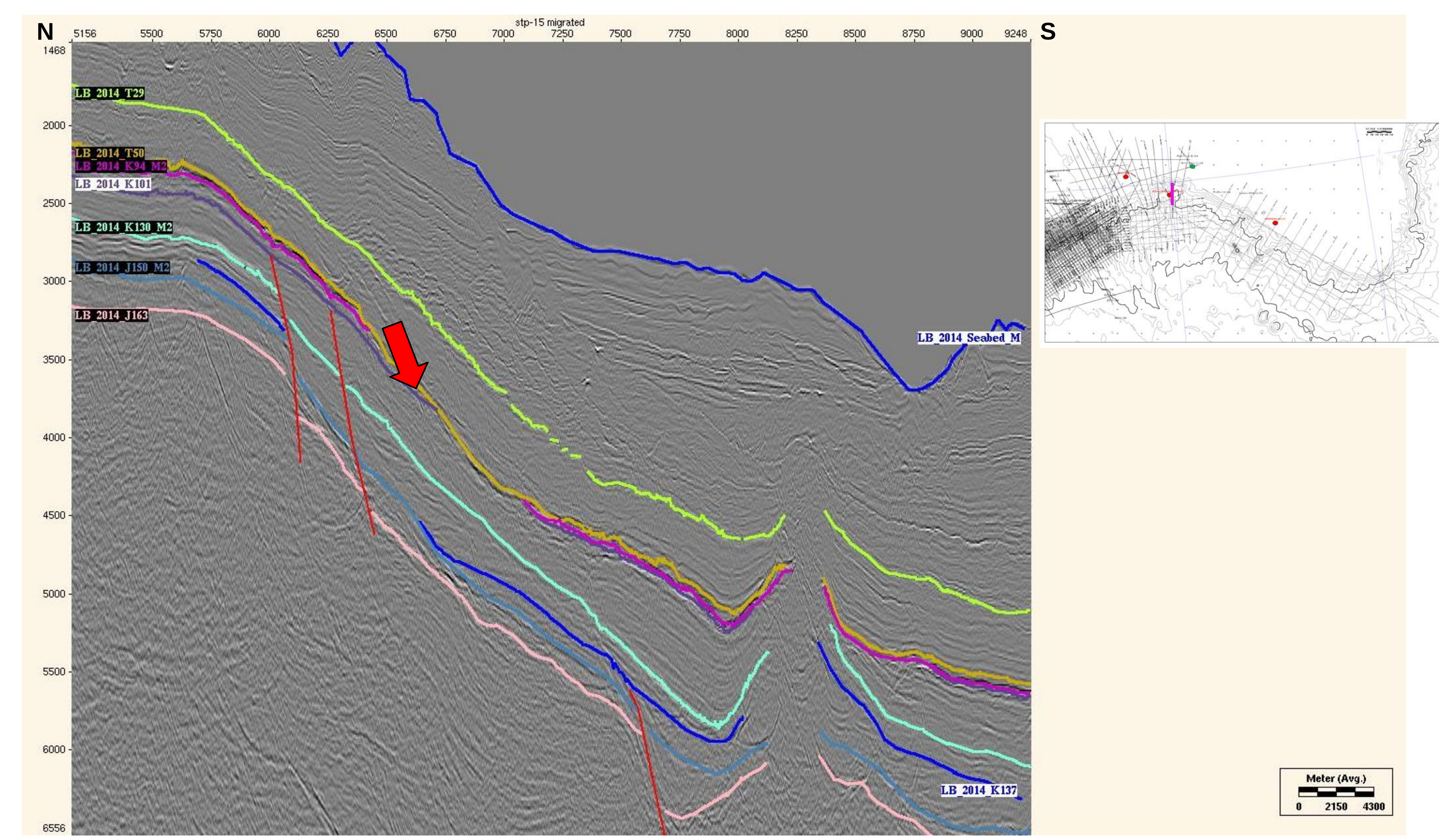
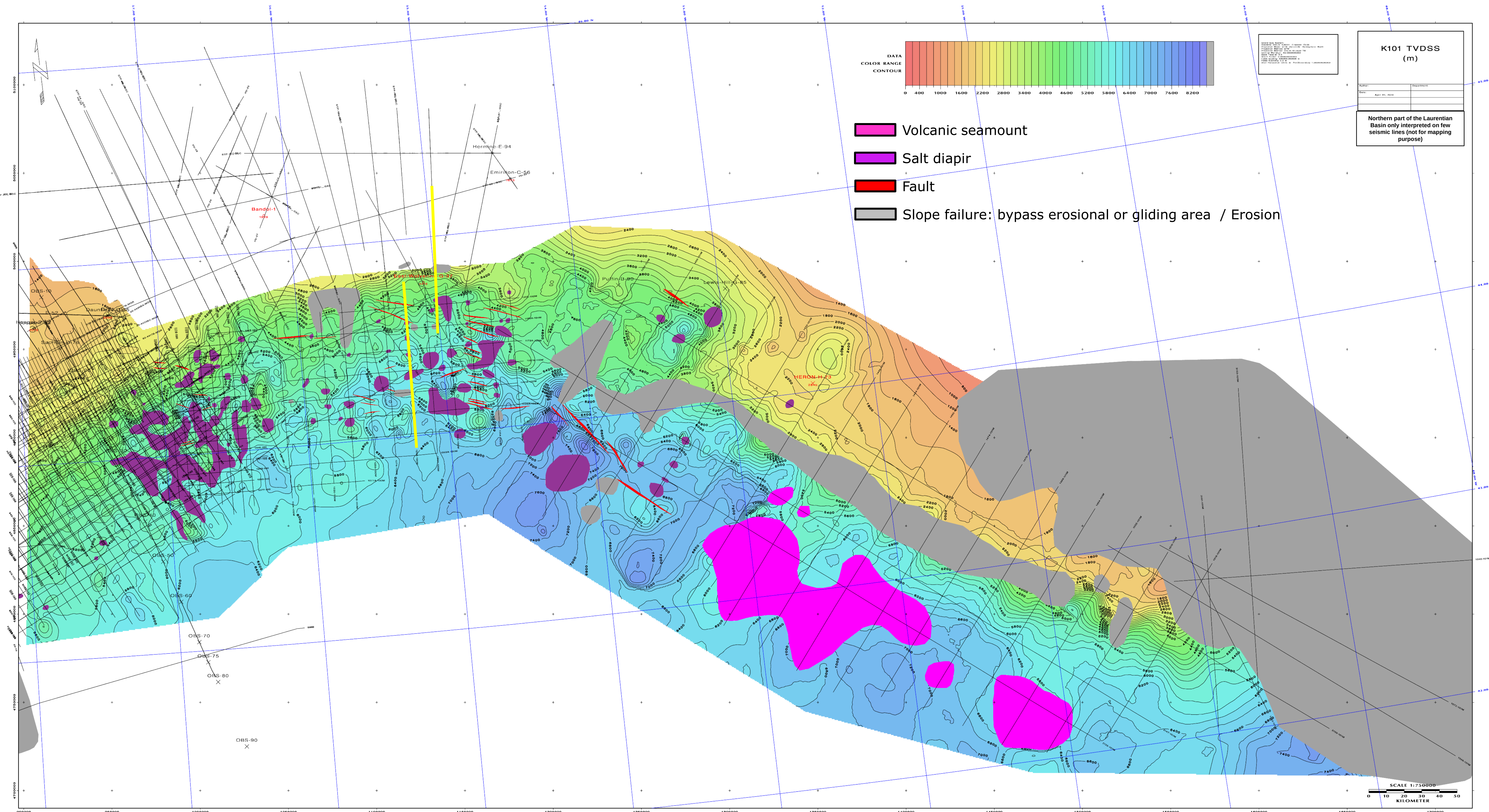


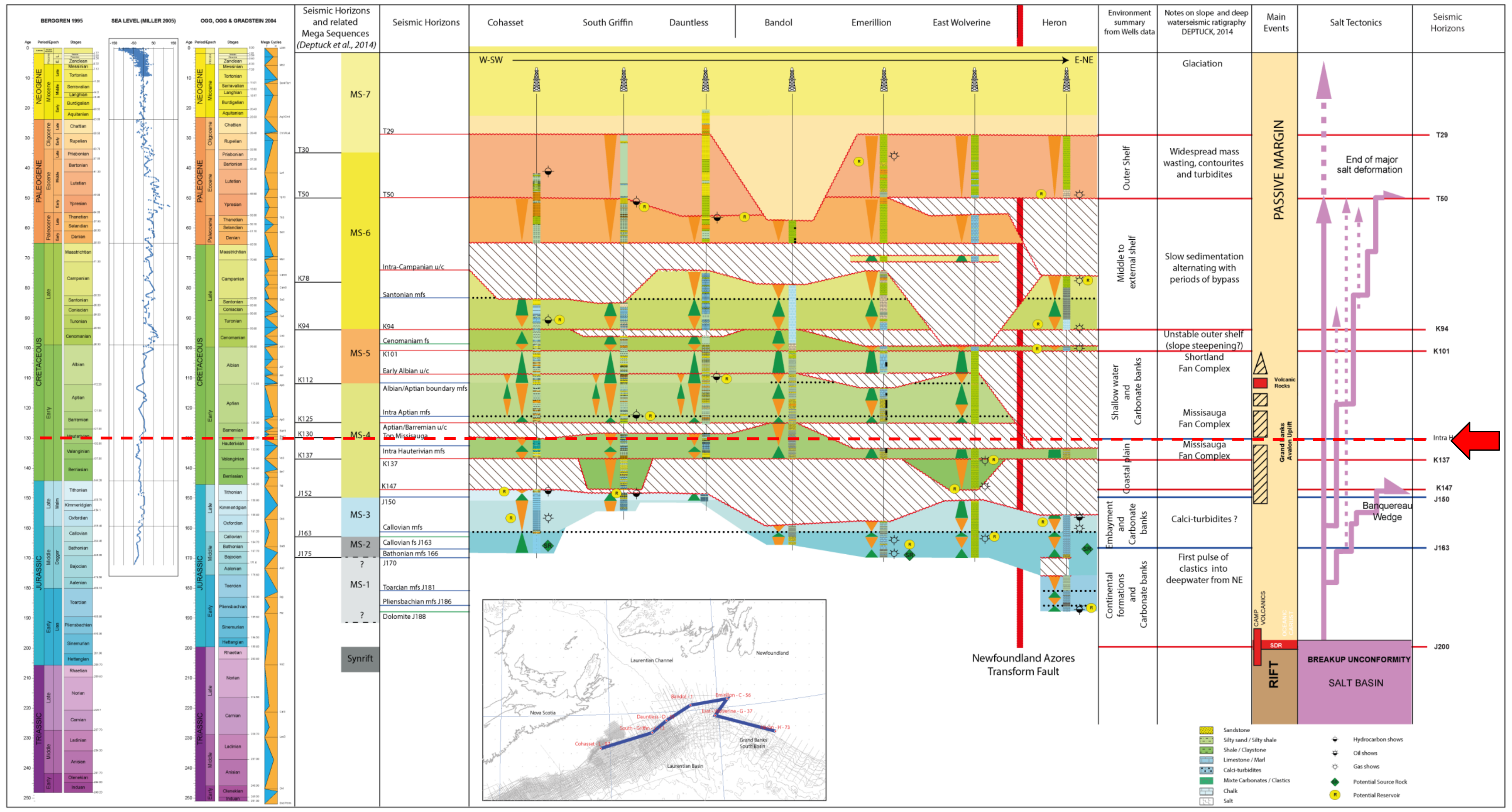
Figure 2 : Seismic line in the slope of the Laurentian Sub Basin showing K101 truncated by T50



K101 (Late Albian Unconformity) Depth Structural Map

PLATE 7.3.9

Tectono-stratigraphical chart



Horizon definition

The horizon named "Hauterivian MFS" (or K130) corresponds to a regional maximum flooding surface (MFS) which occurred 130 Ma ago. It is approximately equivalent on the shelf to the so called "O" marker.

Well-to-seismic tying

The Hauterivian MFS was encountered only on the reference well Bandol-1 on the shelf. It is displayed as a fairly strong amplitude event at the onset of a mixed carbonate-terrigeneous platform in relation to a major drop in sediment supplies on the margin. More precisely, the seismic marker corresponds to the top of a relatively continuous carbonate layer with an increase of acoustic impedance due to high density and velocity carbonates. The well-to-seismic tie results present a good correlation.

Seismic picking and uncertainty

K130 is picked confidently on the shelf of the Laurentian Sub Basin with the Bandol-1 well-to-seismic calibration, and with the integration of the seismic interpretation of CNSOPB and of Nova Scotia Play Fairway Analysis 2011. Whereas K130 does not occur eastwards on the shelf of South Whale Basin, on which the interpretation is only constrained by the biostratigraphic results (erosion by K101). On the slope of the Laurentian Sub Basin, K130 is locally eroded; otherwise the picking is there uncertain due to normal faulting. Within the basin the picking is partly constrained by the more obvious and deeper position of the K137 unconformity where sub-salt imaging difficulties make the picking of the Hauterivian MFS more uncertain away from the well ties; both horizons are in this case often difficult to differentiate from each other.

Structural description

Only the western part of the shelf and, North of Heron-H-73 well, is not eroded. There, K130 horizon is dipping Southeast without any major fault.

Erosion affects a large part of K130 horizon, especially in the South Whale Basin and the Western Grand Banks of Newfoundland. There, a major slope failure (bypass erosional or gliding area) occurs along the preexisting Jurassic carbonate platform due to starved conditions during Cretaceous and Cenozoic times.

On the slope of the Laurentian Sub Basin, K130 horizon is largely eroded around the well East-Wolverine-G-37, and elsewhere steeps toward the basin with few deltaic faults in particular in the western part of the slope. Basinwards, K130 is pierced by still numerous salt domes, even if it is located locally below most of allochthonous salt bodies. Turtle back structures developed sometimes when K130 is below the allochthonous salt layer, and are influenced by autochthonous salt mobilization.

Eastwards, no more salt dome affects K130 but significant Early Cretaceous volcanic seamounts (Fogo type) prevent the deposition of K130 locally. Maximum depths of K130 horizon are interpreted to be located in the distal part of the South Whale Basin.

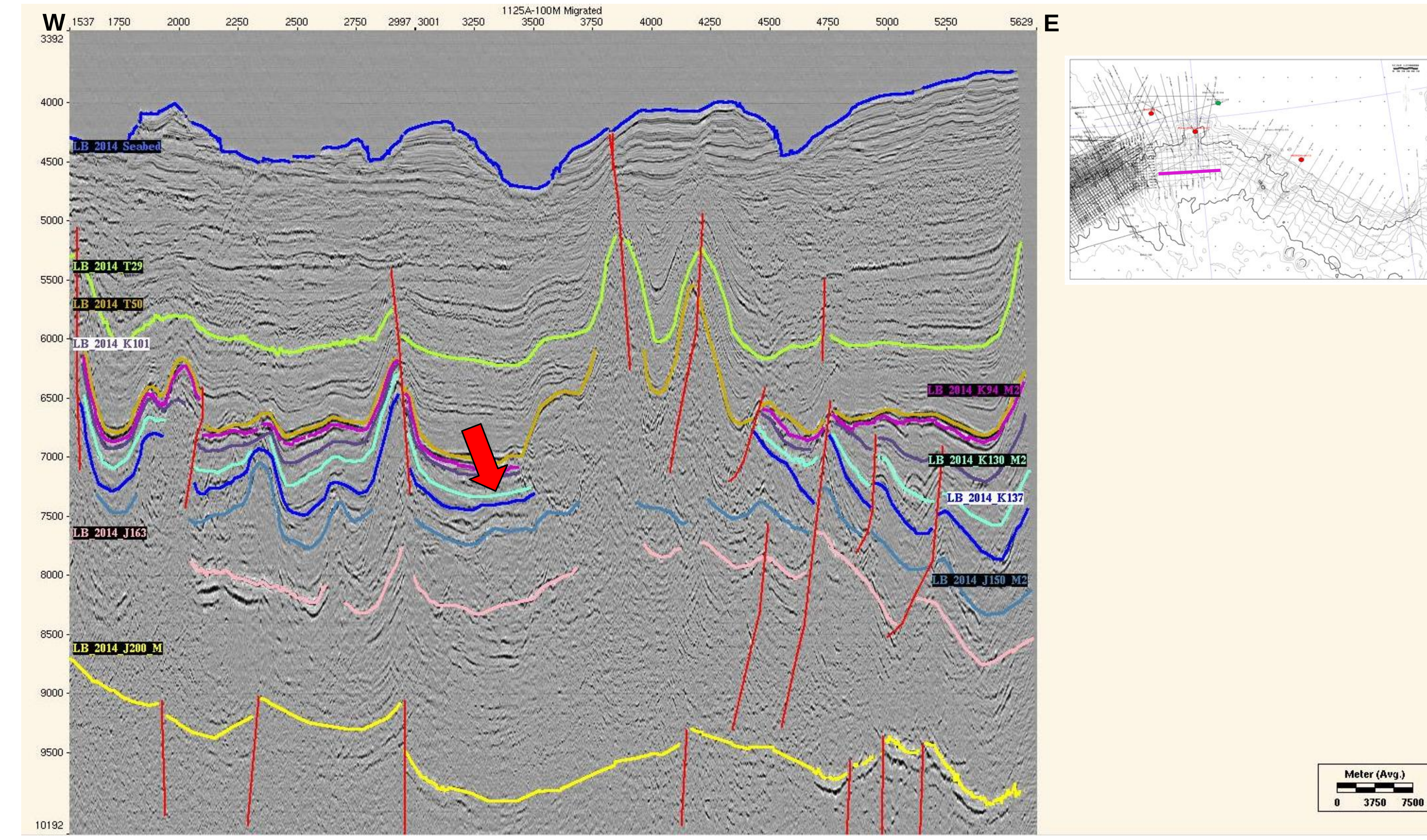


Figure 1 : Seismic line in the Laurentian Sub-Basin showing salt domes piercing K130

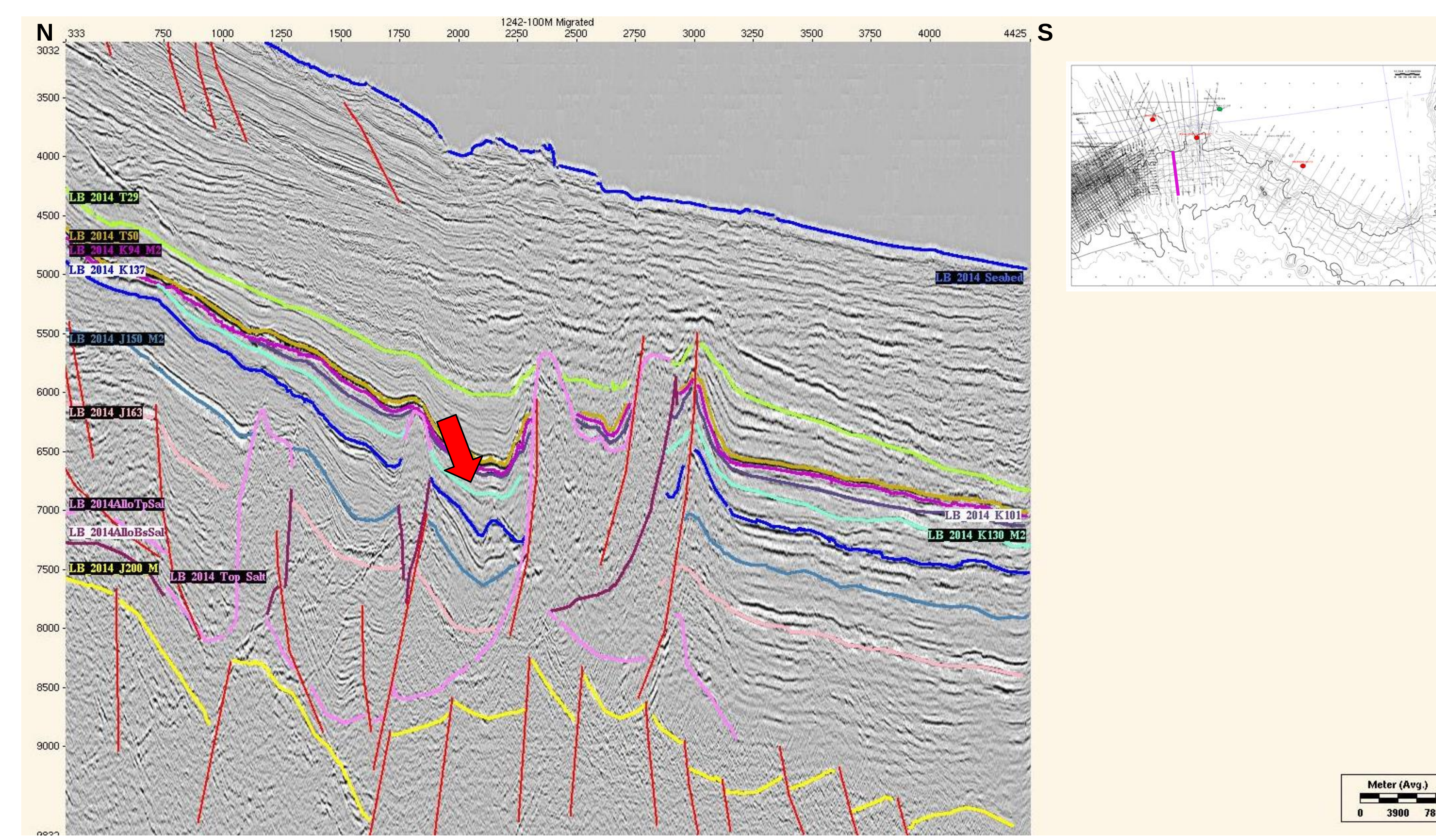
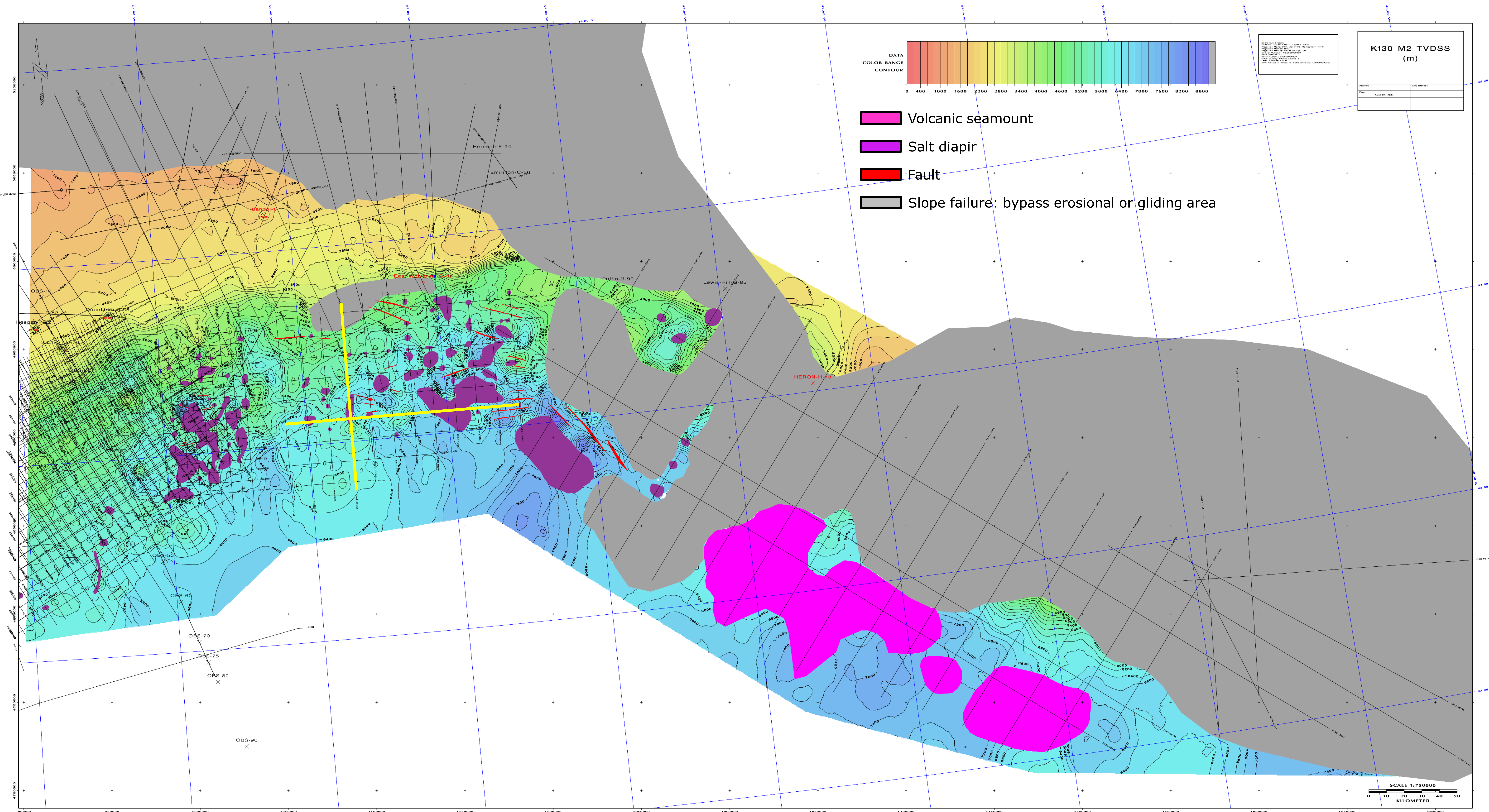


Figure 2 : Seismic line in the slope of the Laurentian Sub Basin showing K130 steeping to the basin

SEISMIC INTERPRETATION – STRUCTURAL MAPS

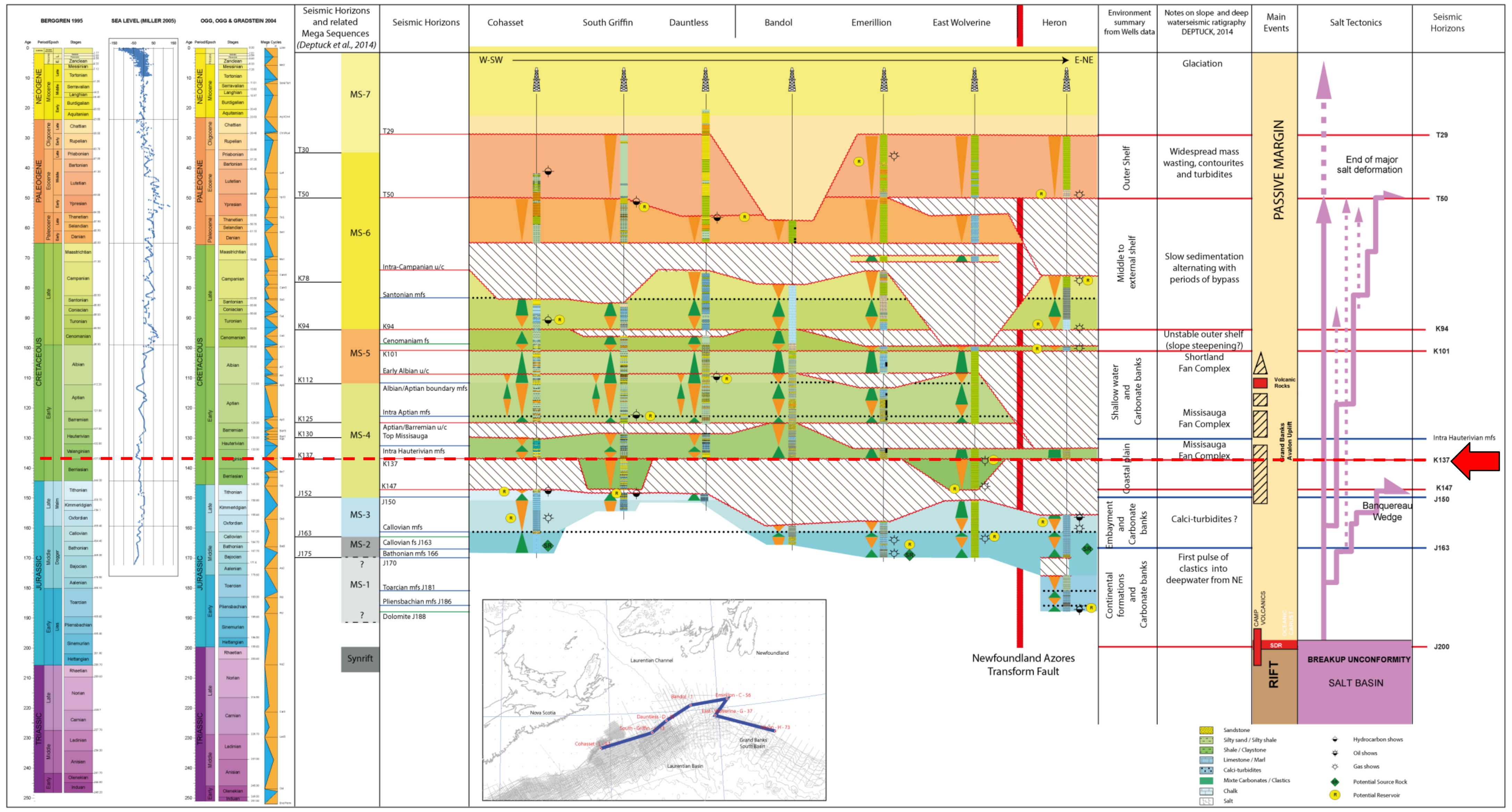
Laurentian sub-basin study - CANADA – June 2014



K130 (Hauterivian MFS) Depth Structural Map

PLATE 7.3.11

Tectono-stratigraphical chart



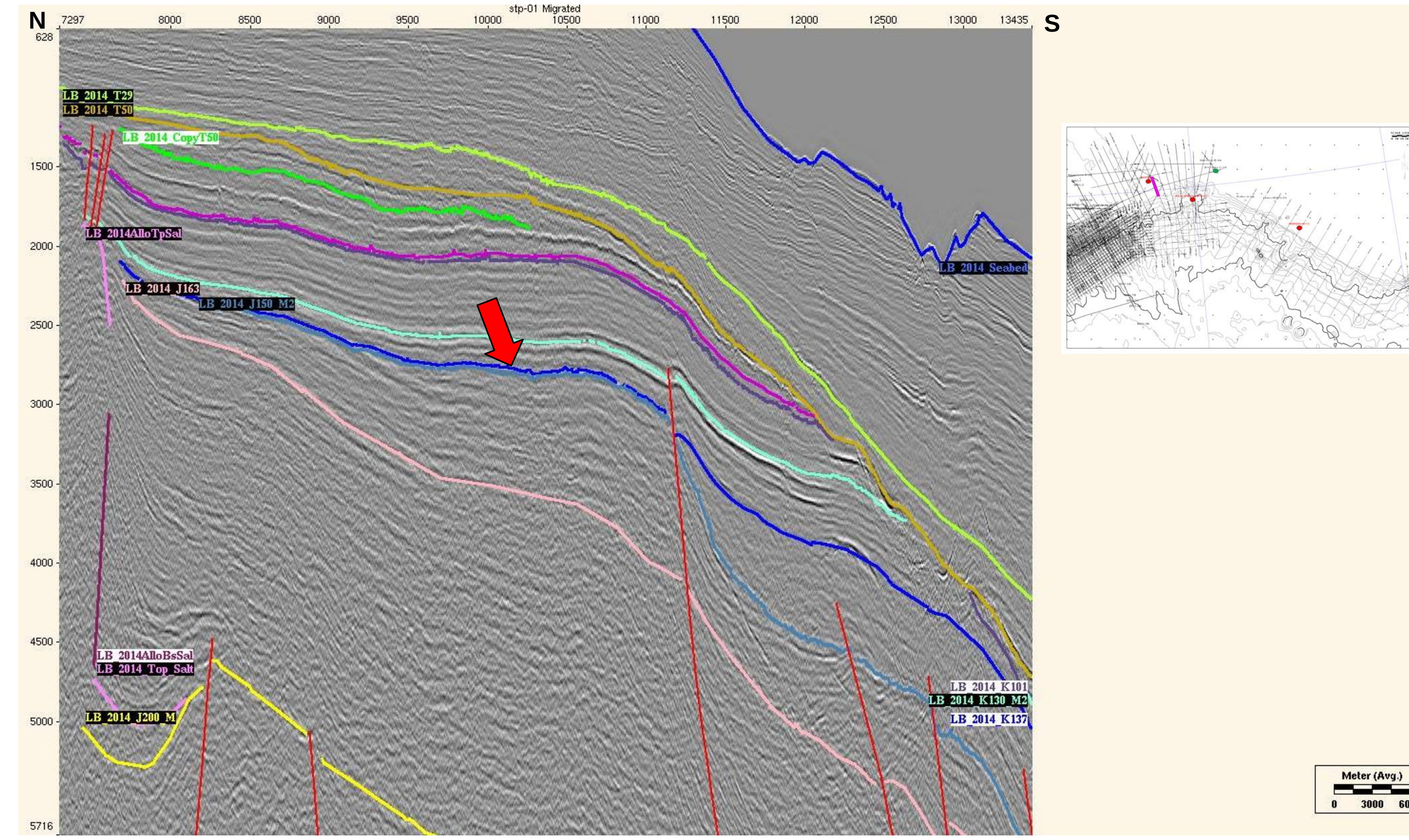


Figure 1 : Seismic line in the Laurentian Sub-Basin showing K137 eroding J150 and J163

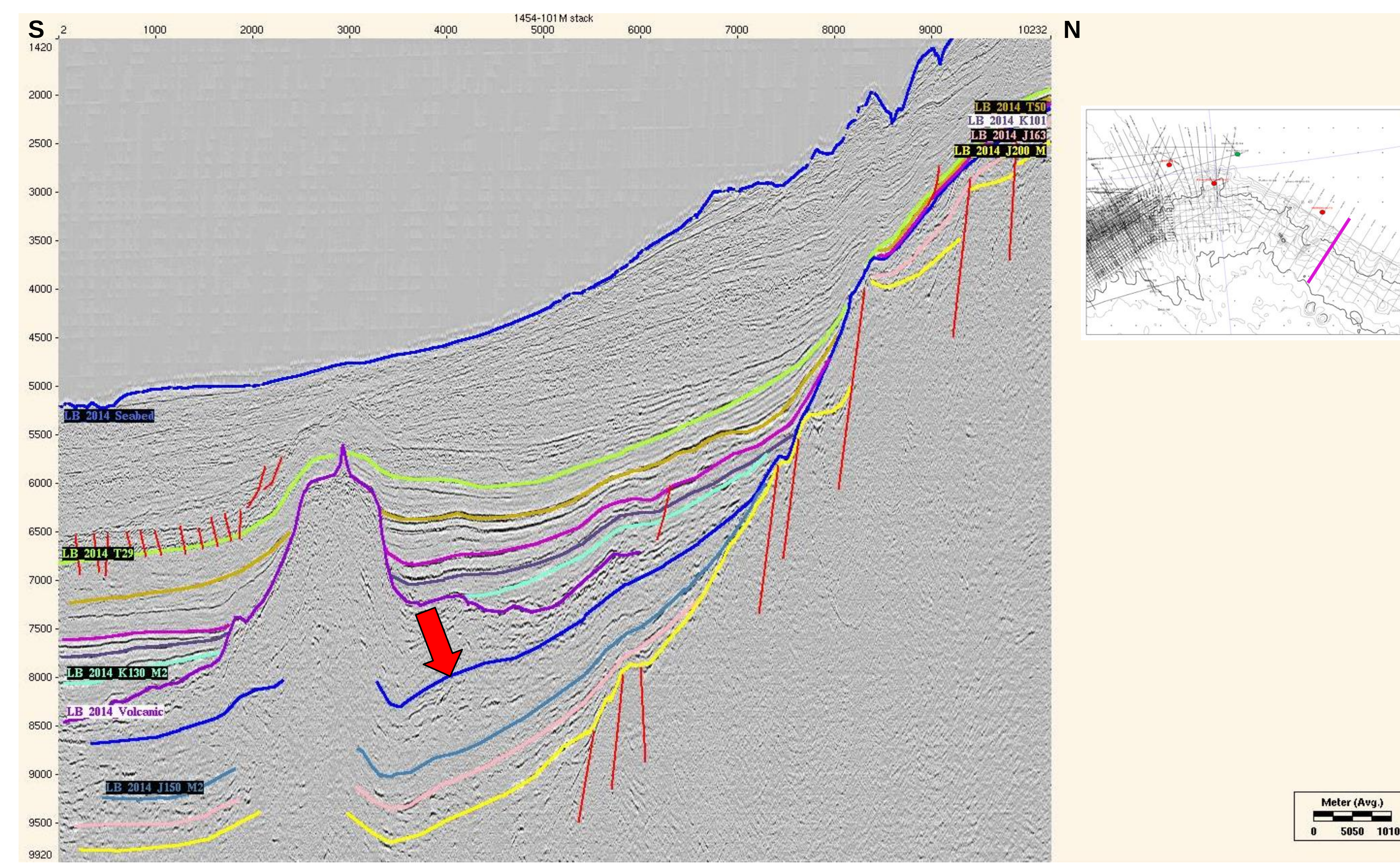


Figure 2 : Seismic line in the slope of the Laurentian Sub Basin showing Early Cretaceous Fogo seamount above K137, and a mini-volcano above the seamount

Horizon definition

The seismic horizon named “Berriasian / Valanginian Unconformity” (or K137) corresponds to a regional unconformity which ranges from 147 Ma to 137 Ma in relation to the Avalon uplift (Keen et al. 2000, Bowman, 2010). On the shelf, it is interpreted as a sub-aerial unconformity.

Well-to-seismic tying

The well-to-seismic tie of the horizon K137 is possible in the three reference wells and in the additional well Emerillon-C-56. it corresponds to the Berriasian / Valanginian unconformity and is clearly identifiable from the Laurentian Sub Basin to the South Whale Basin. In Heron-H-73 well, the unconformity led to sandstones lying on a carbonate layer; the contrast of lithology corresponds to a sharp trough on seismic, whereas it is weaker but still noticeable on the other wells. The well-to-seismic tie results present a very good correlation.

Seismic picking and uncertainty

On the shelf, the picking of the Berriasian / Valanginian unconformity is relatively confident. Where the Tithonian to Berriasian interval is reduced or absent, the K137 event interferes with the underlying J150 seismic reflection. On the slope, the normal fault system and the average quality of the seismic make the picking uncertain away from well ties, even if the erosional character can be more obvious to observe than the K130 MFS. In the deep offshore area, the Berriasian / Valanginian unconformity is only based on seismic facies changes between overlying higher amplitudes shallow marine terrigeneous deposits and the underlying low amplitude Tithonian shales. It is marked as an average to good minimum amplitude (white trough).

Structural description

In the shelf domain, K137 horizon is uniformly dipping South in the Laurentian Sub Basin, and dipping to the Southwest close to the Western Grand Banks of Newfoundland. The Berriasian / Valanginian unconformity is an erosional surface which is relatively conformable in the deep basin (correlative conformity), and evolving to a clear angular unconformity northwards on the shelf of the Laurentian Sub Basin.

Few erosion affect K137 on the slope with only one area at the Northeast of the well East-Wolverine-H-37. Although K137 horizon is located frequently below the allochthonous salt sheet, salt weld, salt feeder (regional and counter-regional fault) and salt pillows affect this horizon in the basin (Laurentian Sub Basin and South Whale Basin). Eastwards, no more salt dome affects K137 but narrow Early Cretaceous volcanic seamounts (Fogo type) prevent the deposition of K137 locally.

It is affected on the slope of the western Laurentian Sub Basin by East / West deltaic faults dipping South. Maximum depths of K137 horizon are interpreted to be located in the distal part of the South Whale Basin.

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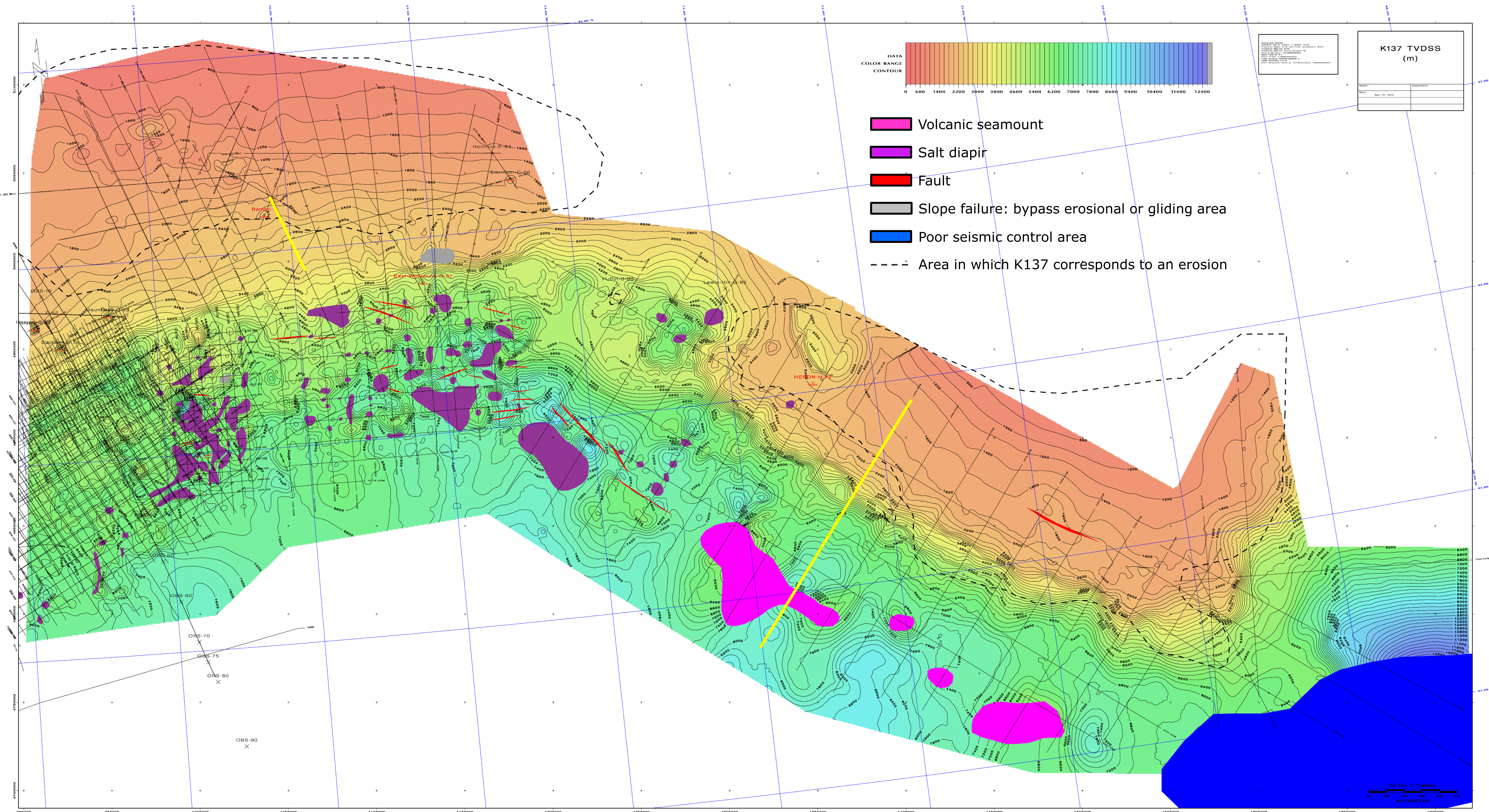
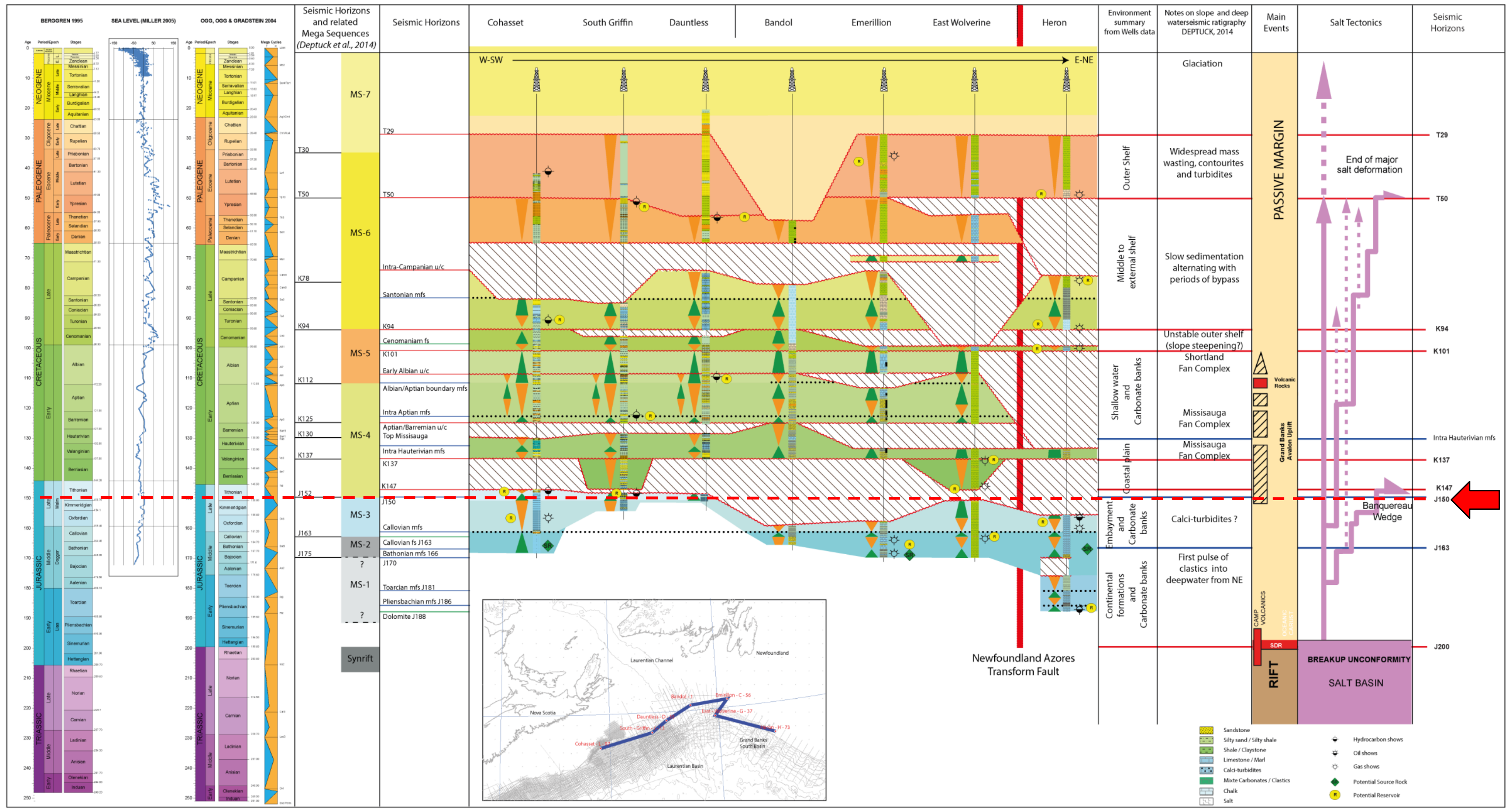


K137 (Berriasian / Valanginian Unconformity) Depth Structural Map

PLATE 7.3.13

Tectono-stratigraphical chart



Horizon definition

The J150 horizon is near below the Tithonian MFS defined by the biostratigraphic study. It corresponds to the Top Baccaro Member of the Abenaki Formation which ends the shallow marine carbonate platform in the western Nova Scotia Margin. To the eastern Laurentian Sub Basin and the South Whale Basin, where the carbonate system evolves into a deltaic system, the J150 horizon corresponds to the Top of the deltaic sandstones of the Mic-Mac formation.

Well-to-seismic tying

The well-to-seismic tie of the horizon J150 is not possible on the reference wells, neither on the additional well Emerillon-C-56 because it is missing in the biostratigraphic record. All of these wells are located on the shelf or in the proximal part of the slope. However the J150 horizon is interpreted to be present basinward. Consequently, the interpretation of the J150 horizon is speculative and only based on seismic facies and correlation with Nova Scotia Play Fairway Analysis 2011 and with the interpretation of CNSOPB. J150 is usually the transition from the clastic deposits to the carbonates of the Baccaro Member.

Seismic picking and uncertainty

The J150 seismic horizon picking is in a large extent the southward and eastward extension of the CNSOPB interpretation in the Laurentian Sub Basin. The poor seismic picking confidence is largely dependent of the absence of the J150 marker in the three reference wells and in the additional well. Moreover, the decreasing of the seismic quality with allochthonous salt occurrence in the Laurentian Sub Basin affects the picking towards the slope. The picking is also very uncertain close to the salt bodies especially in the allochthonous salt province where highly complex structures are added to the subsalt image. In the deep offshore area in which salt is absent, the seismic quality is better and the interpretation becomes more confident despite the lack of well-to-seismic tying.

Structural description

J150 horizon is dipping gently South, when it is not eroded. Faulting corresponds to large regional and counter-regional listric faults parallel to the slope, and sliding on the underlying autochthonous salt layer, and occurred mainly in the basin area (Laurentian Sub Basin and South Whale Basin). Local but on several tens of km length normal faults affect J150 horizon on the slope of the Laurentian Sub Basin and are attributed to East / West deltaic faults dipping South.

J150 is extensively eroded by K137 on the North of the Laurentian Sub Basin and on the East of the South Whale Basin, whereas it is locally eroded all along the slope of the basins. J150 steeps gently on the slope when it is located far from the erosion areas and from the slope faults.

In the basin, although J150 horizon is located frequently below the allochthonous salt sheet, salt weld, salt feeder (regional and counter-regional fault) and salt pillows affect this horizon in the basin (Laurentian Sub Basin and South Whale Basin).

Eastwards, no more salt dome affects J150 but Early Cretaceous volcanic seamounts (Fogo type) prevent the deposition of J150 locally. Maximum depths of J150 horizon are interpreted to be located in the South of the Western Grand Banks.

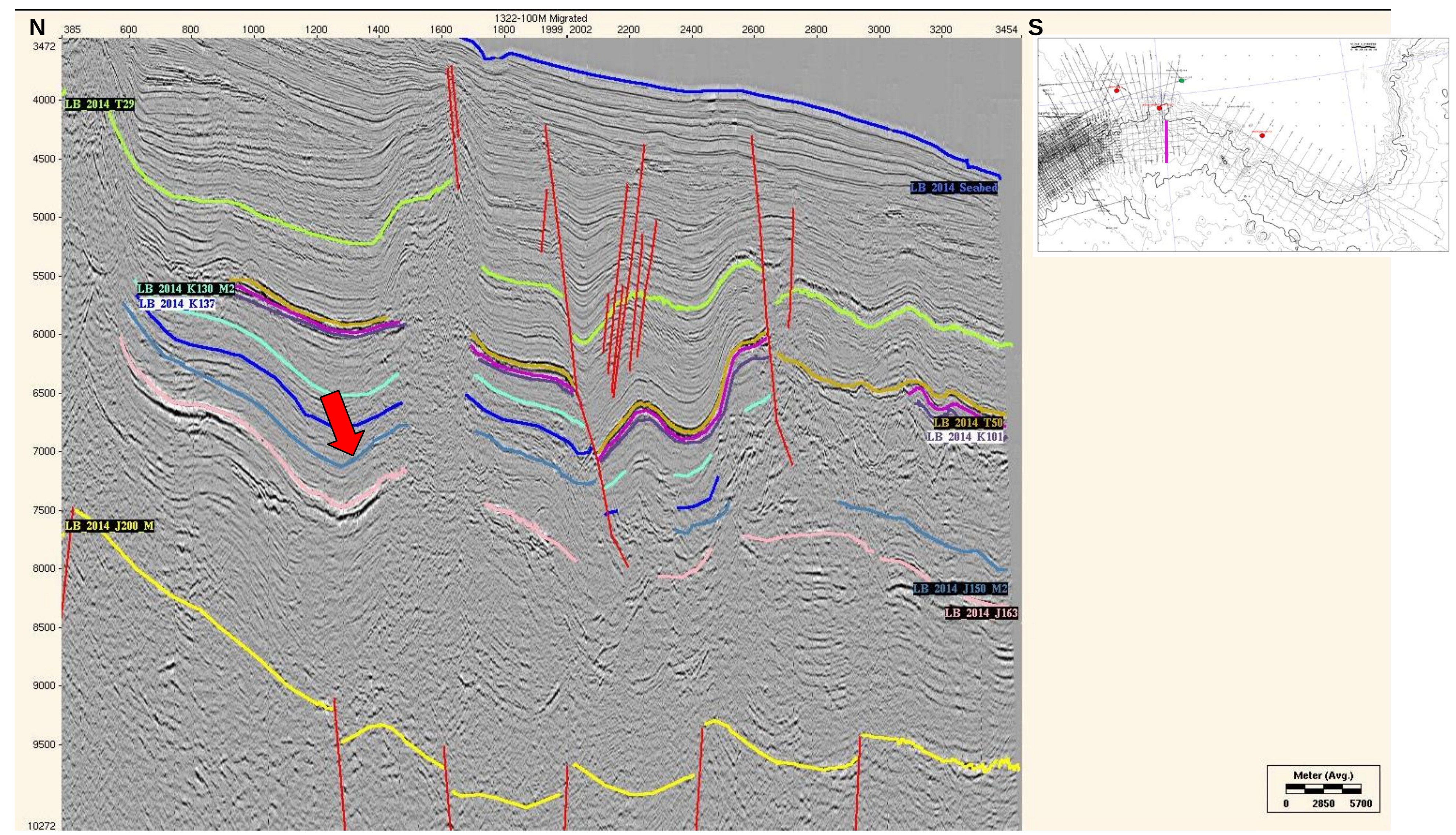
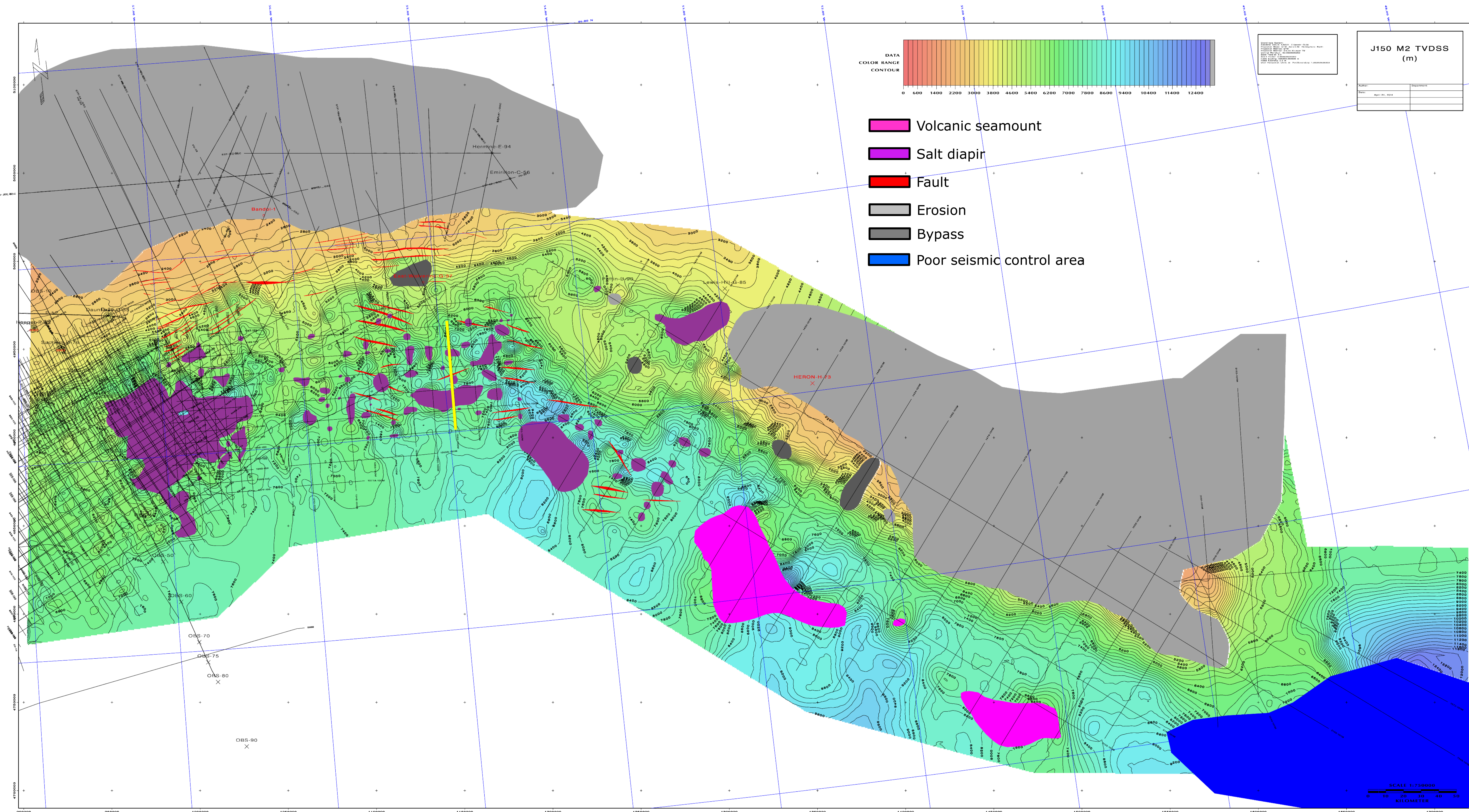


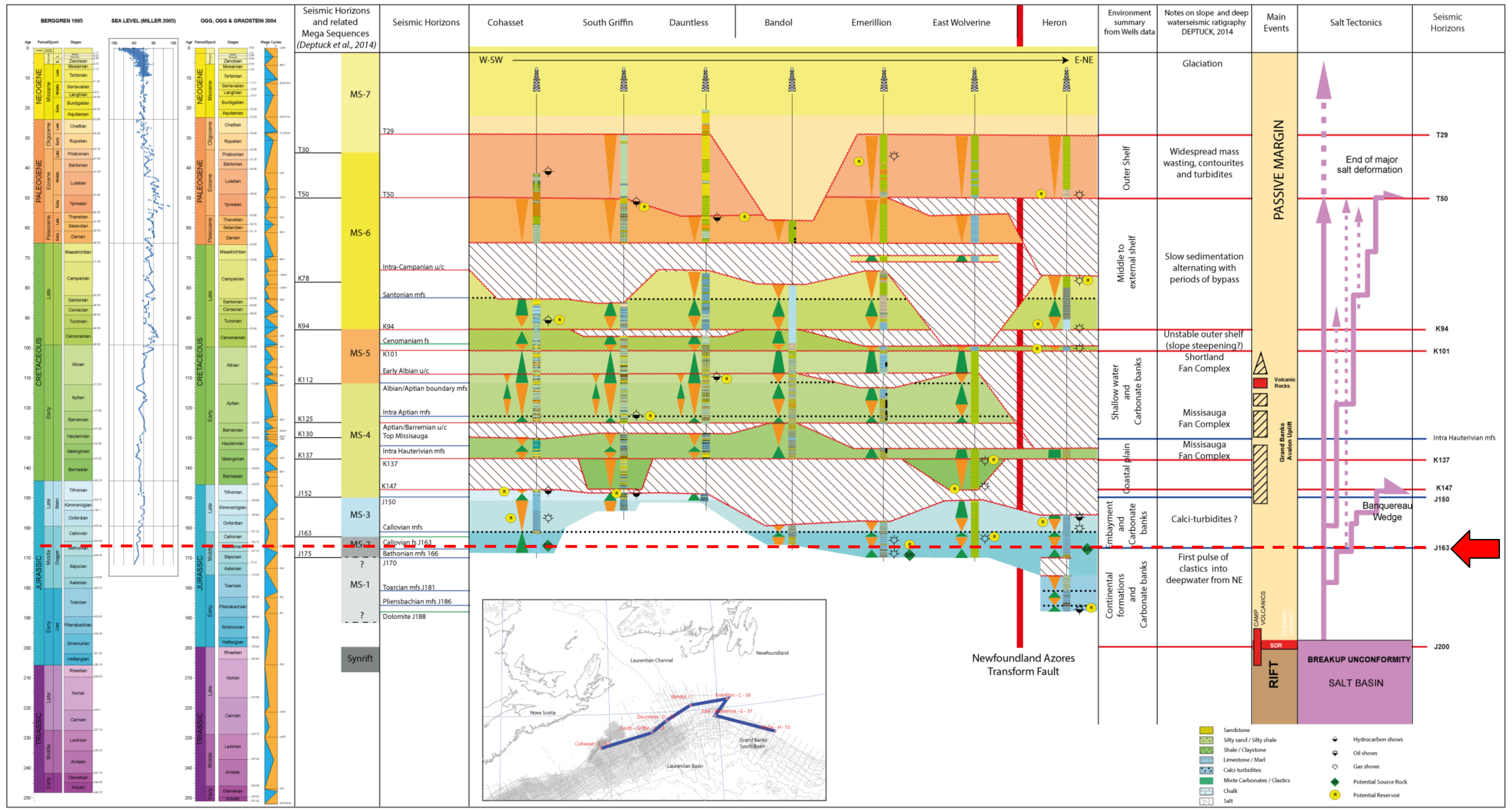
Figure 1 : Seismic line in the Laurentian Sub-Basin showing salt dome piercing K150 to the North, and a allochthonous salt body above J150 to the South



J150 Depth Structural Map

PLATE 7.3.15

Tectono-stratigraphical chart



Horizon definition

The J163 seismic horizon is close (near below) the Callovian FS identified in the biostratigraphic study. It corresponds to the Top of the Scatarie Member of the Abenaki Formation. It forms the onset of the shallow marine carbonate platform deposition.

Well-to-seismic tying

The well-to-seismic tie of the horizon J163 is possible on all the reference wells and the additional well Emerillon-C-56. The horizon J163 is the transition between the shale of the Misaine Member and the carbonates of the Scatarie Member. Seismically, it corresponds to a positive peak as an increase of acoustic impedance creates a positive amplitude on zero-phase seismic in normal polarity according the SEG convention. The well-to-seismic calibration of Bandol-1 took also largely into consideration the result of the calibration of the well Dauntless-D-35. The well-to-seismic tie results present a good correlation.

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Seismic picking and uncertainty

The seismic picking of the J163 horizon is good on the shelf area with a sharp positive reflection. The seismic imaging quality decreases on the slope and in the offshore area mainly due to salt tectonics. Indeed, the picking is very uncertain close to the salt bodies especially in the allochthonous salt province (Laurentian Sub Basin) where highly complex structures are added to the subsalt images. In the deep offshore area in which salt is absent, the seismic quality is better and the interpretation becomes more confident despite the lack of well-to-seismic tying.

Structural description

The 163 horizon is dipping gently and uniformly to the South. Faulting corresponds to large regional and counter-regional listric faults parallel to the slope, and sliding on the underlying autochthonous salt layer, and occurred mainly in the basin area (Laurentian Sub Basin and South Whale Basin). Locally, but on several tens of km length, normal faults affect J163 horizon on the slope of the Laurentian Sub Basin and are attributed to East / West deltaic faults dipping South.

J163 is extensively eroded by K137 on the North of the Laurentian Sub Basin and on the East of the South Whale Basin. J150 steeps on the slope chaotically when:

- it was bypassed or it glided locally on the slope of the eastern South Whale Basin;
- or it is pierced by salt diapirs as in the South Whale Basin.

In the basin, although J163 horizon is located frequently below the allochthonous salt sheet, salt weld, salt feeder (regional and counter-regional fault) and salt pillows affect this horizon in the basin (Laurentian Sub Basin and South Whale Basin).

Eastwards, no more salt dome affects J163 but Early Cretaceous volcanic seamounts (Fogo type) prevent the deposition of J150 locally. Maximum depths of J163 horizon are interpreted to be located in the South of the Western Grand Banks.

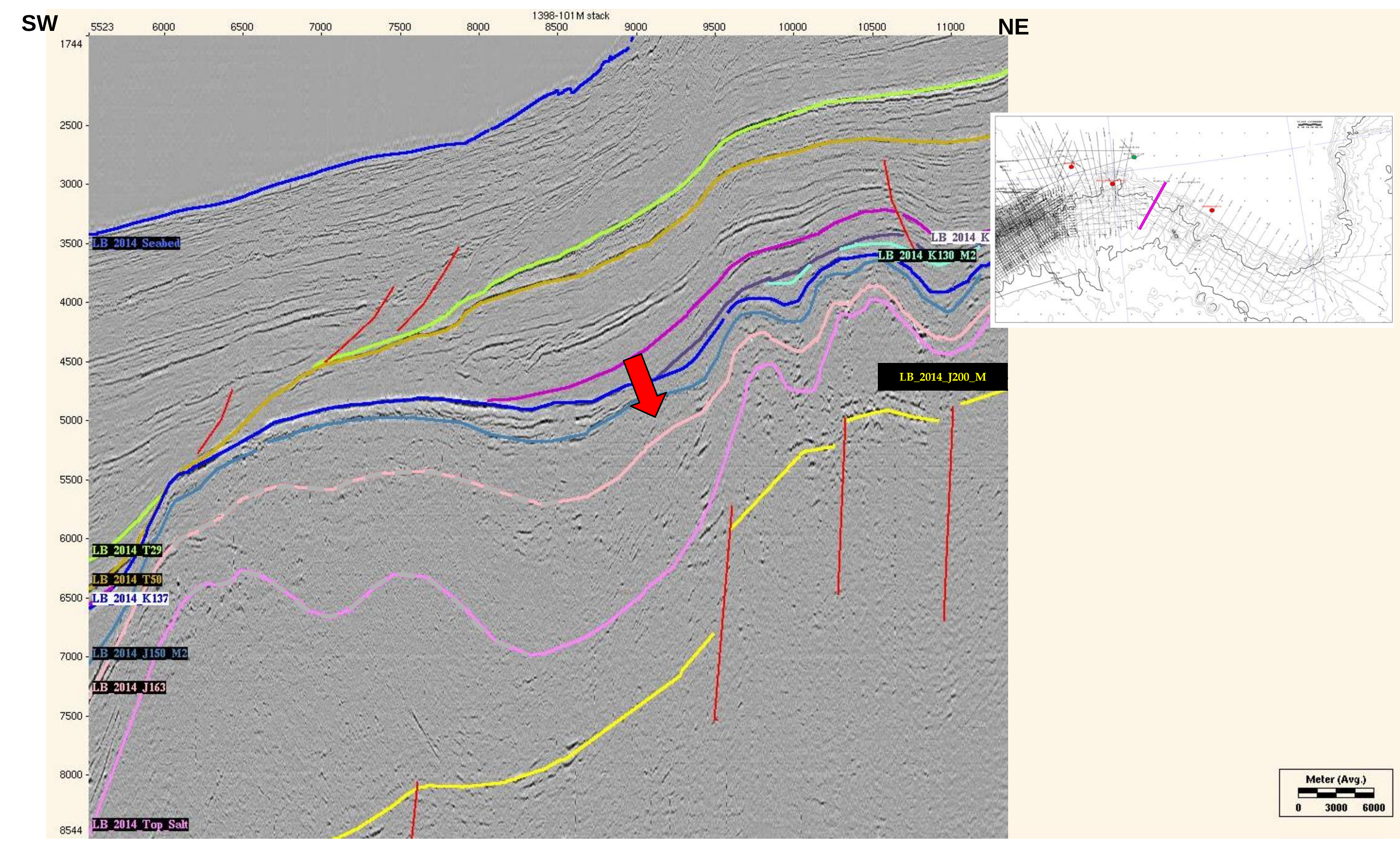

Figure 1 : Seismic line in the eastern South Whale Basin showing J163 deformed by autochthonous salt mobilization above the Base Post Rift sediments. Southwards, Top J163 is interpreted on the TVDSS map (Plate 7.3.17) to pinch out on the salt diapir. It should be thus associated with a bigger salt diapir than the one picked on the seismic section in dashed lines. Due to poor seismic quality in this area, it may be also interpreted not to be pierced by this salt diapir (as depicted on the seismic section in dashed lines).

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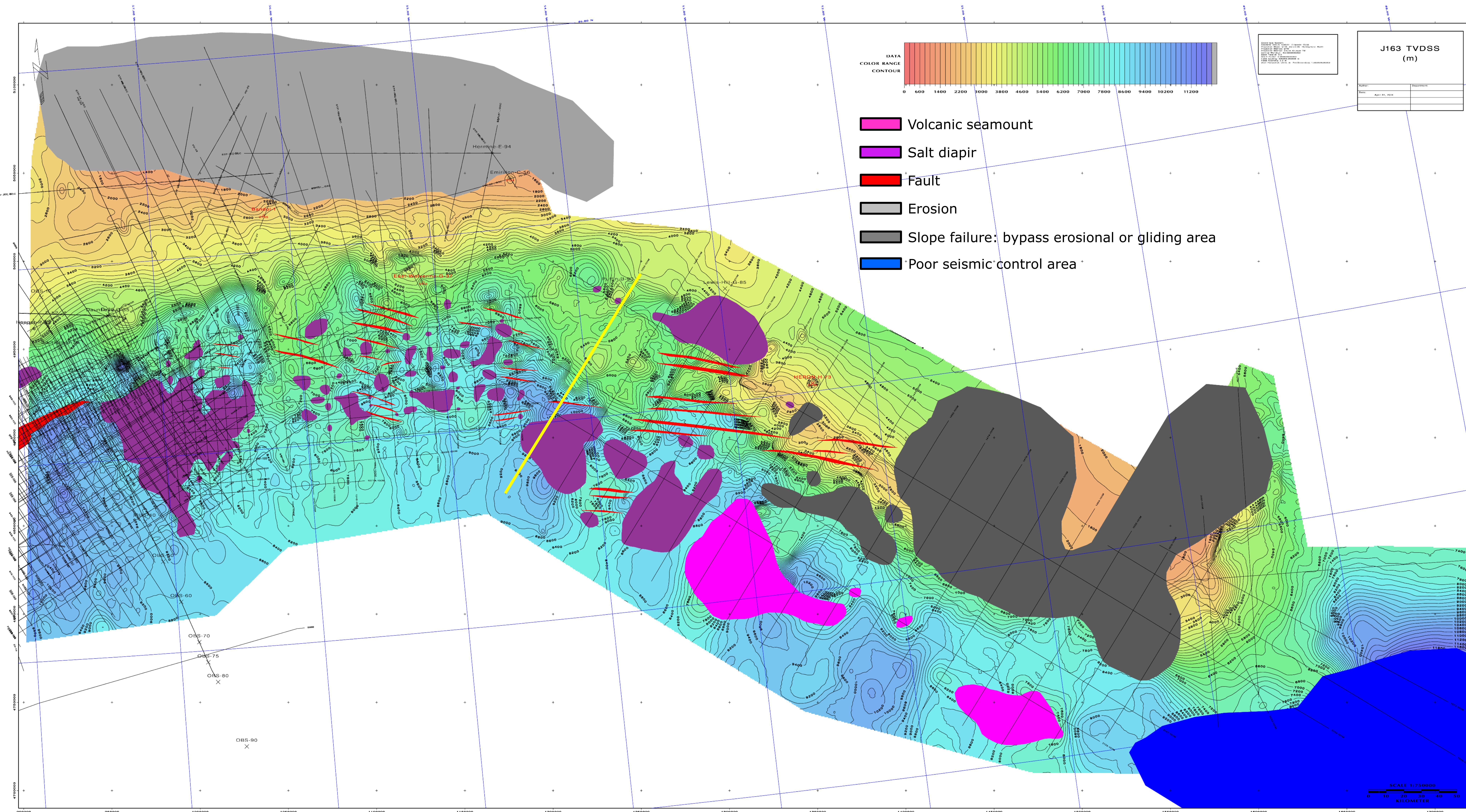
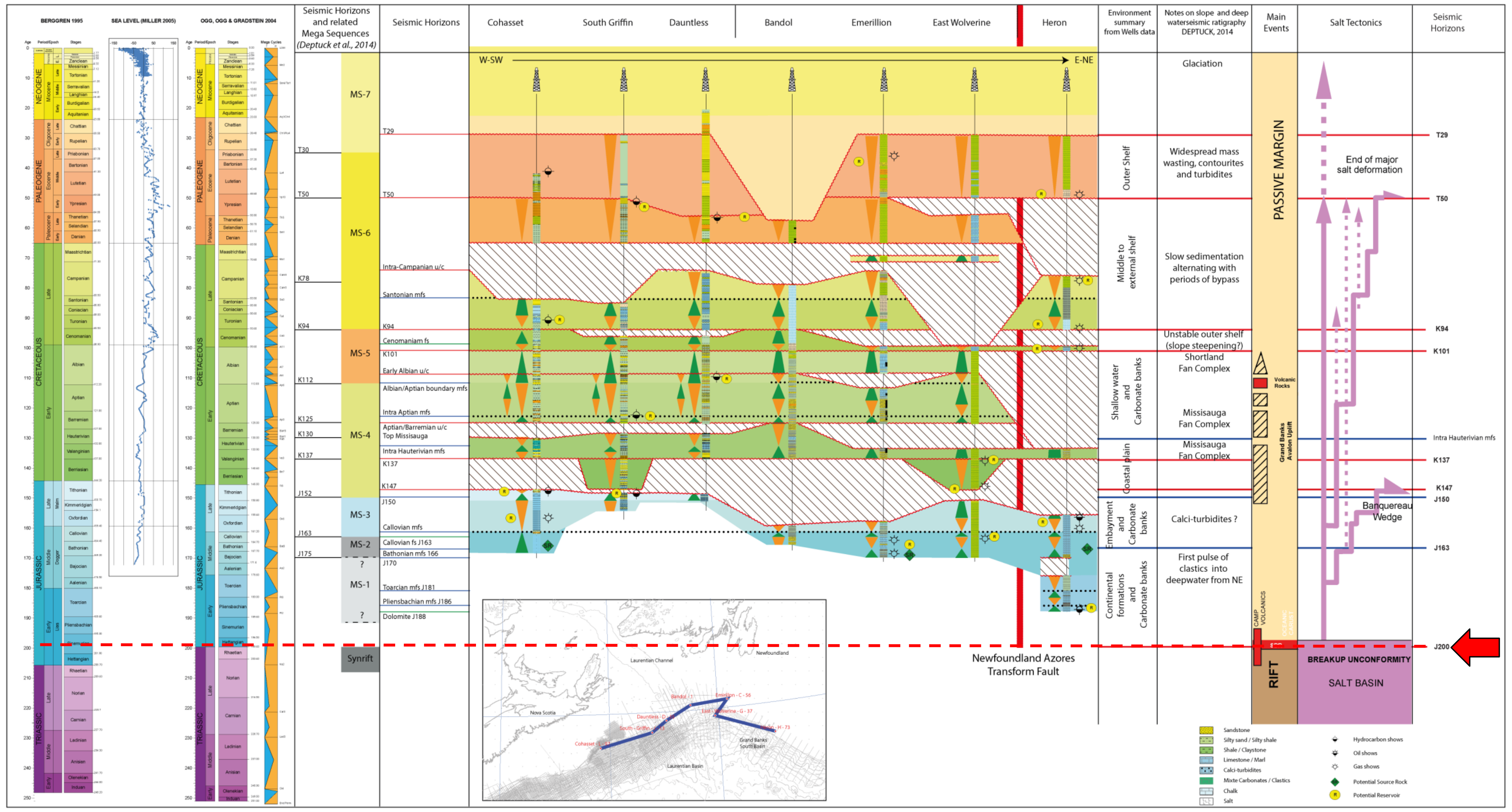


J163 Depth Structural Map **PLATE 7.3.17**

Tectono-stratigraphical chart



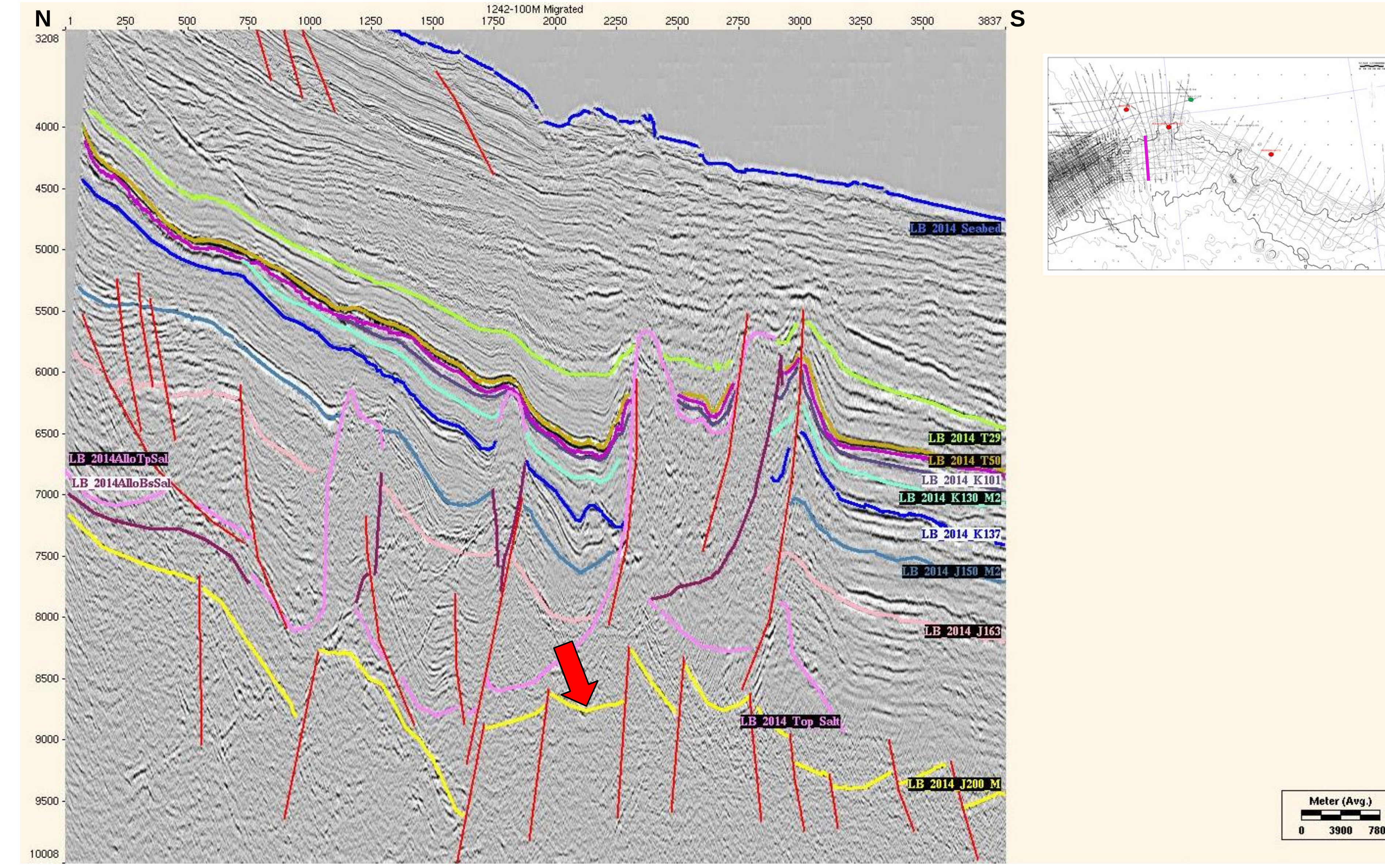


Figure 1 : Seismic line in the Laurentian Sub-Basin showing the interaction between the Triassic faults and the overlying position of the salt diapirs

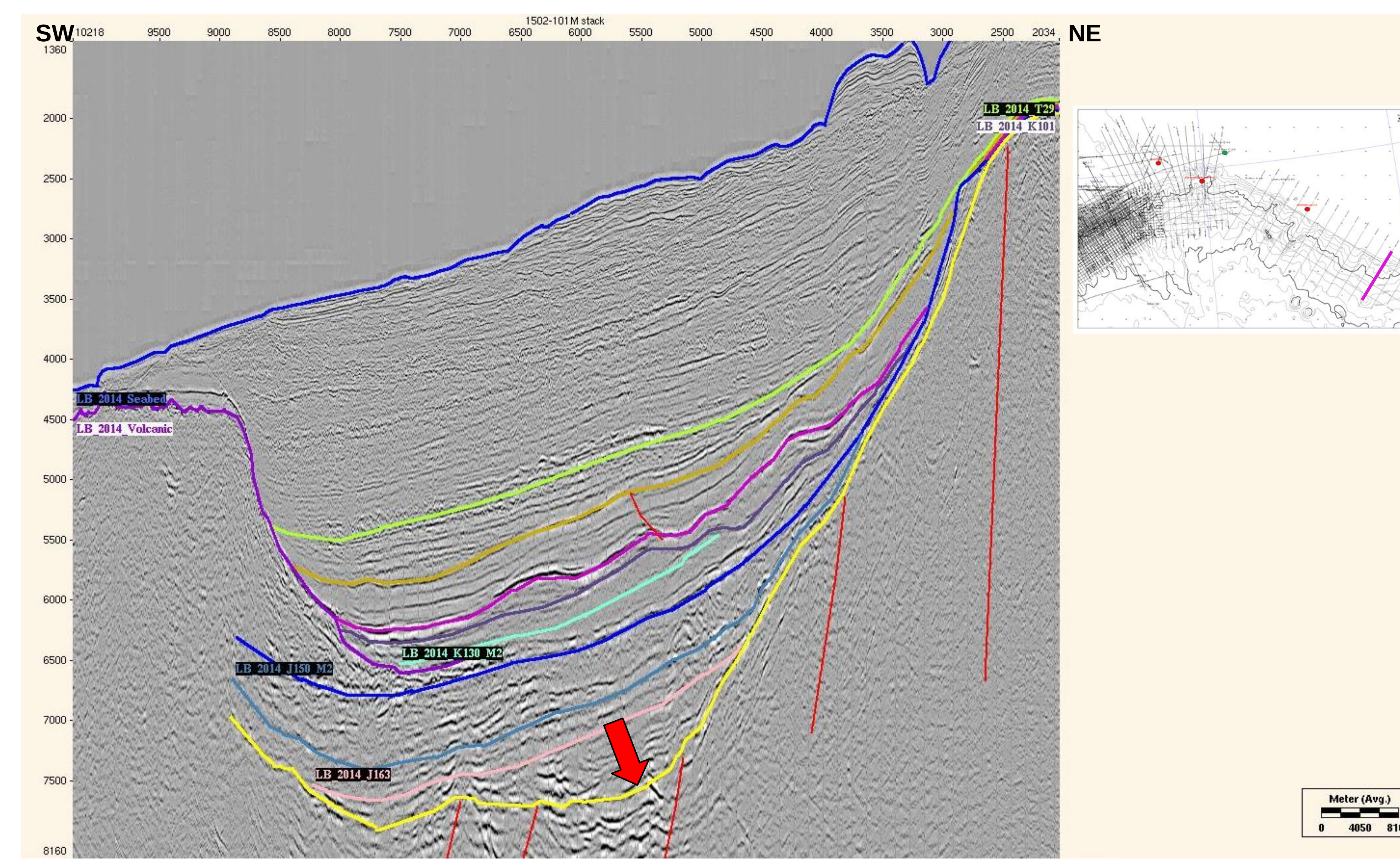


Figure 2 : Seismic line in the South Whale Basin showing Early Cretaceous Fogo seamount above the Base Post Rift sediments

Horizon definition

The horizon named "Base of the Post Rift sediments" is the deepest horizon picked on seismic. On the continental shelf, it corresponds to the top of the Basement (undifferentiated Carboniferous or Triassic series) and the base of the Argo Salt when present in the sub-basins. On the slope, the horizon is identified as the base of the Argo Salt in the Laurentian Sub Basin and the South Whale Basin. Seawards, in the deep offshore area, the horizon has been picked at the top of seaward dipping reflectors (SDRs) when occurring, and equivalent top of Oceanic Crust.

Well-to-seismic tying

No reference well, neither the additional well Emerillon-C-56 penetrated deep enough in the Triassic series. As a consequence, no well-to-seismic tying is possible in the studied area, and the interpretation of the "Base of the Post Rift sediments" is very speculative, and based on seismic facies, on the correlation with Nova Scotia Play Fairway Analysis 2011 and on the result of the Dauntless-D-35 calibration.

Seismic picking and uncertainty

The structural complexity (normal faulting with large throw) and the poorly imaged seismic interval makes the picking very uncertain. The uncertainty is increased by the absence of well penetrating the Base of Post Rift sediments. The seismic event is characterized by an average to poor seismic reflection with poor lateral seismic continuity. From the continental shelf into the slope, the seismic interpretation of this horizon is very speculative, and is only constrained locally by the base of the Argo Salt on the shelf and, in the basin, by also the base of the Argo Salt or some stronger reflections or even by SDRs interpreted as the top of the Oceanic Crust at the Southeast of the Laurentian Sub Basin.

Structural description

The "Base of the Post Rift sediments" is dipping gently South in the Laurentian Sub Basin and dipping Southwest in the South Whale Basin and the Western Grand Banks of Newfoundland.

Extensive faults oriented Northwest / Southeast affect the slope of the South Whale Basin to the Western Grand Banks of Newfoundland, and delimit clearly the shelf from the basin. Others oriented Northeast / Southwest affect the slope of the Laurentian Sub Basin. Several normal faults of smaller size cut the horizon in some small grabens in the proximal part of the Laurentian Sub Basin, and are oriented East / West to Northeast / Southwest.

It is only broken in the deep offshore by two basement highs located in the South Whale Basin.

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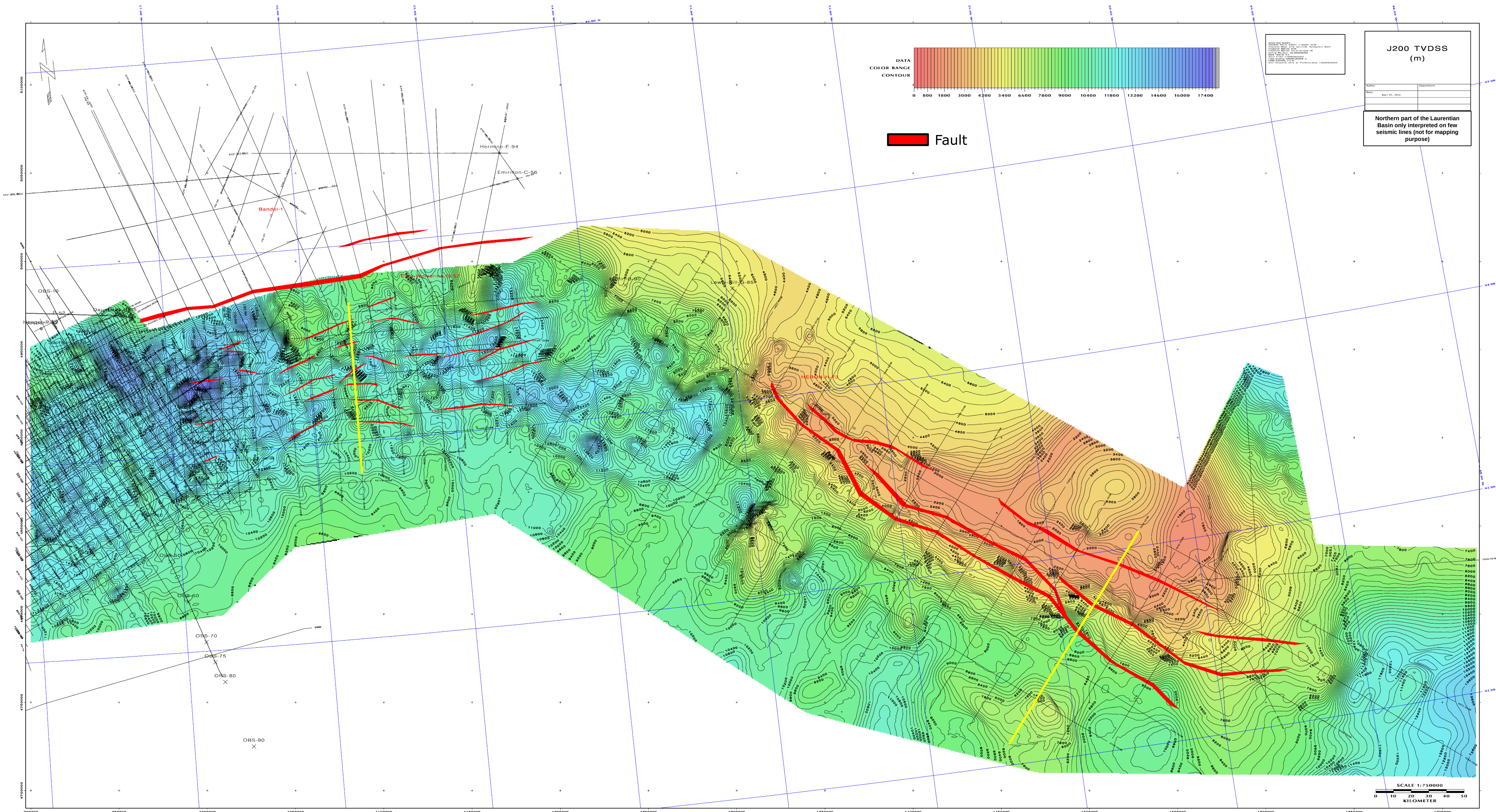

Base of Post Rift Sediments Depth Structural Map **PLATE 7.3.19**